NOVEMBER 1984

INITIAL ASSESSMENT STUDY OF NAVAL WEAPONS CENTER CHINA LAKE, CALIFORNIA

NEESA 13-060

NAVAL ENERGY AND ENVIRONMENTAL SUPPORT ACTIVITY
Port Hueneme, California 93043

AR #16

PREFACE

The U.S. Navy has initiated a program to identify, evaluate and control any adverse environmental impact resulting from past use and disposal of industrial/military substances on Navy owned or controlled lands. The program consists of three phases with the first step being to identify all waste disposal sites and assess which of those sites warrant further study as to their potential for present or future environmental hazards. The first step has recently been completed at the Naval Weapons Center with the issuance of this Initial Assessment Study (IAS). Subsequent efforts (phases) will investigate sites recommended for confirmation, and if necessary, implement cleanup of any sites with potential adverse environmental impact.

In making the general assessment of potential environmental impact, the IAS study team used an evaluation tool called the Confirmation Study Ranking System (CSRS) that considers three rating factors: (1) the hazardous characteristics of the waste material; (2) existence of any sensitive environmental resources that could be adversely affected; and (3) the existence of migration pathways from source sites to sensitive environmental elements. These factors are combined in a model that assigns a value of relative potential hazard based on a scoring system that ranges from 0 to 100. A "0" means no potential hazard and a 100 indicates a high probability of severe hazard to humans or environmental resources.

The Center's IAS has identified 42 waste sites that were rated using the CSRS model. Of these 42 sites: 28 sites are assigned "0" ratings because one of the three rating factors was equated to "0" which, based on the model, eliminates any potential for adverse environmental impact; 14 sites received ratings between 2.5 and 12.4 which indicates that no immediate threat exists to human health or the environment, but that a further evaluation step called a Confirmation Study is warranted. The Table below lists the 14 sites recommended for confirmation studies in order of priority, score, and the reason for requiring confirmation. Note that five of the sites are recommended for confirmation studies solely because of potential impact to the Mojave Chub. The Mojave Chub is a federally listed endangered fish species transplanted from Soda Dry Lake near Baker, California to the Center in 1971 in a special effort designed to ensure the Chub's survival as a species.

As the Initial Assessment Study is read, it should be kept in mind that it does not determine actual risk or hazard posed by a site. It simply identifies sites that have potential hazards and establishes priorities for conducting the Confirmation Studies. At present hazardous wastes are not being buried at the Naval Weapons Center and the contaminated sites discussed in this IAS were created in the past when burial of such wastes was considered acceptable and safe. During the Confirmation Study process, the Center will continue to confer with regulatory agencies. If the confirmation studies show that any sites are an actual threat to health or environmental resources, appropriate remedial cleanup actions will be developed and implemented. Congress is providing special funds to ensure the military cleanup of such sites proceeds in a timely fashion and these funds are being allocated to the cleanup of the sites posing the greatest threat on a national basis in order to minimize health and environmental damage nation-wide. The Naval Weapons Center fully supports the Navy's goal of controlling environmental contamination resulting from past use and disposal of hazardous substances.

CONFIRMATION STUDY

	SITE	RANKING SCORE	REASON FOR CONFIRMATION
1.	Site #29, C-1 East Disposal Area	12.4	Potential contamination to potable groundwater
2.	Site #22, Pilot Plant Road Landfill	9.6	Potential contamination of potable groundwater
3.	Site #31, Public Works Pesticide Rinse Area	9.5	Potential contamination to potable groundwater
4.	Site #7, Michelson Laboratory Drainage Ditches	9.0	Potential contamination of Mojave Chub habitat Potential contamination of potable groundwater
5.	Site #12, SNORT Road Landfill	8.3	Potential contamination of potable groundwater
6.	Site #3, Armitage Field Leach Pond	7.5	Potential contamination of Mojave Chub habitat
7.	Site #13, Oil Waste Disposal Area	6.0	Potential contamination of Mojave Chub habitat Potential contamination of potable groundwater
8.	Site #32, Golf Course	5.3	Potential contamination of Mojave Chub habitat Potential contamination of potable groundwater
9.	Site #16, G-1 Range	4.8	Potential contamination of Mojave Chub habitat
10.	Site #27, NAF Disposal Site	3.1	Potential contamination of potable groundwater
11.	Site #14, ER Range Septic System	3.1	Potential contamination of Mojave Chub habitat
12.	Site #15, R Range Septic System	2.6	Potential contamination of Mojave Chub habitat
13.	Site #17, G-2 Range Septic System	2.5	Potential contamination of Mojave Chub habitat
14.	Site #34, Lauritsen Road Landfill	2.5	Potential contamination of Mojave Chub habitat Potential contamination of potable groundwater

INITIAL ASSESSMENT STUDY

NAVAL WEAPONS CENTER

CHINA LAKE, CALIFORNIA

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EXECUTIVE SUMMARY

This report presents the results of an Initial Assessment Study (IAS) conducted at the Naval Weapons Center (NAVWPNCEN) China Lake, California. The purpose of an IAS is to identify and assess sites posing a potential threat to human health or to the environment due to contamination from past hazardous materials utilization.

Ground water contamination is the principal area of concern in the NAVWPNCEN area. This is because contamination from sites in the south and west portions of the China Lake complex can migrate into a ground water aquifer used as the potable water source for Indian Wells Valley residents. In addition, contamination from other sites in the more central portion of the China Lake complex can migrate into ground water which discharges to the China Lake Playa. Seeps on the southern edge of this playa (the G-1 seep and Lark seep, which are connected by a canal) provide habitat for an endangered fish species (Mohave chub) that could be adversely affected by pollutants.

Based on information from historical records, aerial photographs, field inspections, and personnel interviews, a total of 42 potentially contaminated sites were identified at NAVWPNCEN, China Lake. Each of the sites was evaluated with regard to contamination characteristics, migration pathways, and pollutant receptors.

The study concludes that, while none of the sites pose an immediate threat to human health or to the environment, 14 warrant further investigation under the Navy Assessment and Control of Installation Pollutants (NACIP) program to assess potential long-term impacts. Confirmation studies involving sampling and monitoring of the 14 sites are recommended to confirm or deny the presence of the suspected contamination and to quantify the extent of any problems which may exist. The 14 sites recommended for confirmation are listed below in order of priority:

1. Site No. 29, C-1 East Disposal Area
2. Site No. 22, Pilot Plant Road Landfill
3. Site No. 31, Public Works Pesticide Rinse Area
4. Site No. 7, Michelson Lab Drainage Ditches
5. Site No. 12, SNORT Road Landfill
6. Site No. 3, Armitage Field Leach Pond
7. Site No. 13, Oily Waste Disposal Area
8. Site No. 32, Golf Course Pesticide Rinse Area
9. Site No. 16, G-1 Range Septic System
10. Site No. 27, NAF Disposal Area
11. Site No. 14, ER Range Septic System
12. Site No. 15, R Range Leach Field
13. Site No. 17, G-2 Range Septic System
14. Site No. 34, Lauritsen Road Disposal Area

The results of the Confirmation Studies will be used to evaluate the necessity of conducting remedial measures or cleanup operations. It is recommended that the location of all 42 sites be noted on NAVWPNCEN development maps so that future land uses can be regulated as appropriate.

NEPSS

Naval Environmental Protection Support Service

FOREWORD

The Department of the Navy developed the Navy Assessment and Control of Installation Pollutants (NACIP) Program to identify and control environmental contamination from past use and disposal of hazardous substances at Navy and Marine Corps installations. The NACIP program is part of the Department of Defense Installation Restoration Program, and is similar to the Environmental Protection Agency's "Superfund" program authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

In the first phase of the NACIP program, a team of engineers and scientists conducts an Initial Assessment Study (IAS). The IAS team collects and evaluates evidence of contamination that may pose a potential threat to human health or the environment. The IAS includes a review of archival and activity records, interviews with activity personnel, and an on-site survey of the activity. This report documents the findings of an IAS at the Naval Weapons Center (NAVWPNCEN) China Lake, California.

Confirmation Studies under the NACIP program were recommended for 14 sites at NAVWPNCEN. Western Division, Naval Facilities Engineering Command (WESTNAVFACENGCOM), will assist NAVWPNCEN in implementing the recommendations.

Questions regarding this report should be referred to the Naval Energy and Environmental Support Activity, 112N, at AUTOVON 360-3351, FTS 799-3351, or commercial (805) 982-3351. Questions concerning confirmation work or other follow-on efforts should be referred to WESTNAVFACENGCOM, 114, at AUTOVON 859-7494, FTS 448-7494, or commercial (415) 877-7494.

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ACKNOWLEDGEMENTS

The Initial Assessment Study team commends the support, assistance, and cooperation provided by personnel at Naval Weapons Center (NAVWPNCEN) China Lake, California; Western Division, Naval Facilities Engineering Command (WESTNAVFACENGCOM); Naval Energy and Environmental Support Activity (NAVENENVSA); and Ordnance Environmental Support Office (OESO). In particular, the IAS team gratefully acknowledges the outstanding effort provided by the following people, who participated in the successful completion of the study.

- Thomas M. Dodson, NAVWPNCEN China Lake
- Henry Shanks, WESTNAVFACENGCOM
- Pam Clements, OESO
- John Edkins, Project Manager, NAVENENVSA

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CHAPTER 1. INTRODUCTION

1.1 PROGRAM BACKGROUND. Past hazardous waste disposal methods, although acceptable at the time, have often caused unexpected long-term problems through release of hazardous pollutants into the soil and ground water. In response to increasing national concern regarding these problems, Congress directed the Environmental Protection Agency (EPA) to develop a comprehensive national program to manage past disposal sites. The program is outlined in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of December 1980.

1.1.1 Department of Defense Program. Department of Defense (DOD) efforts in this area preceded the nationwide CERCLA program. In 1975, the U.S. Army developed for DOD a pilot program to investigate past disposal sites at military installations. DOD defined the program as the Installation Restoration Program in 1980 and instructed the services to comply with program guidelines.

1.1.2 Navy Program. The Navy manages its part of the program, the Navy Assessment and Control of Installation Pollutants (NACIP) Program, in three phases. Phase 1, the Initial Assessment Study (IAS), identifies disposal sites and contaminated areas caused by past hazardous substance storage, handling, or disposal practices at naval activities. These sites are then individually evaluated with respect to their potential threat to human health or to the environment. Phase 2, the Confirmation Study, verifies or characterizes the extent of contamination present and provides additional information about migration pathways. Phase 3, Remedial Action, provides the required corrective measures to mitigate or eliminate confirmed problems.

1.2 AUTHORITY. The Chief of Naval Operations (CNO) initiated the NACIP Program in OPNAVNOTE 6240 of 11 September 1980, superseded by OPNAVINST 5090.1 of 26 May 1983. The Naval Facilities Engineering Command (NAVFACENGCOM) manages the program within the existing structure of the Naval Environmental Protection Support Service (NEPSS), which is administered by the Naval Energy and Environmental Support Activity (NAVENENVSA). NAVENENVSA conducts the program's phase 1 IAS in coordination with NAVFACENGCOM Engineering Field Divisions (EFDs). Activities are selected for an IAS by CNO, based on recommendations by NAVFACENGCOM, the regional EFDs, and NAVENENVSA. Approval of Naval Weapons Center (NAVWPNCEN) China Lake, California, for an Initial Assessment Study is given in CNO letter serial 451/3U392444 of 5 July 1983.

1.3 SCOPE.

1.3.1 Past Operations. The NACIP Program focuses attention on past hazardous substance storage, use, and disposal practices on Navy property. Current practices are regularly surveyed for conformity to state and federal regulations, and therefore, are not included in the scope of the NACIP Program. The IAS report addresses operational non-hazardous waste disposal and storage areas only if they were hazardous waste disposal or storage areas in the past. Current operations are investigated solely to determine what types and quantities of materials were used, and what disposal methods were practiced.

1.3.2 Results. If necessary, an IAS recommends mitigating actions to be performed by the activity or EFD, or recommends Confirmation Studies to be administered by the EFD under the NACIP Program. Based on these recommendations, NAVFACENGCOM schedules Confirmation Studies for those sites determined by scientific and engineering judgment to pose a potential threat to human health or to the environment.

1.4 INITIAL ASSESSMENT STUDY.

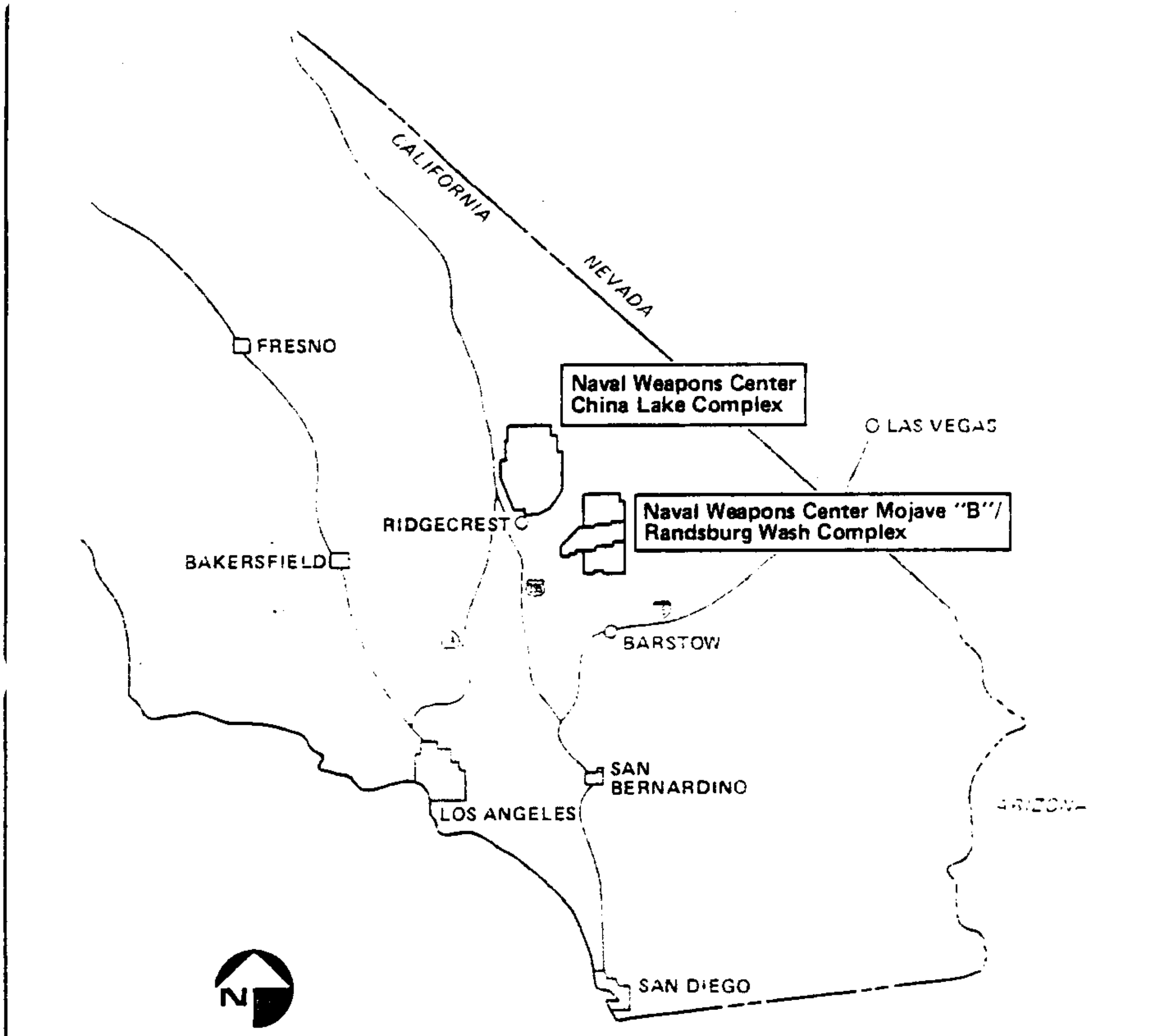
1.4.1 Records Searches. The IAS begins with records searches at various government agencies; including the EFDs, the national and regional archives and record centers, and U.S. Geological Survey offices. In this integral step, study team members review records to assimilate information about the activity's past missions, industrial processes, waste disposal records, and known environmental contamination. Examples of records researched include activity master plans and histories, environmental impact statements, cadastral records, and aerial photographs. Appendix A lists the agencies contacted during this study.

1.4.2 On-Site Survey. After the records searches, the study team conducts an on-site survey to complete documentation of past and present operations and past disposal practices and to identify potentially contaminated areas. With the assistance of an activity point of contact, the team inspects the activity during ground and aerial tours and interviews long-term employees and retirees. The on-site survey for NAVWPNCEN China Lake was conducted from February 28 to March 2, 1984; report information is current as of those dates. A location map that shows the NAVWPNCEN China Lake regional area is presented in Figure 1-1.

Information obtained from interviews is verified by data from other sources or corroborating interviews before inclusion in the report. If information for certain sites is conflicting or inadequate, the team may collect samples for clarification.

1.4.3 Confirmation Study Ranking System. With information collected during the study, IAS team members evaluate each site for its potential hazard to human health or to the environment. A two-step Confirmation Study Ranking System (CSRS), developed at NAVENENVSA, is used to systematically evaluate the relative severity of potential problems. The two steps of the CSRS are a flow chart and a numerical ranking model. In the first step, a flowchart eliminates innocuous sites from further consideration. The flowchart is based on type of waste, type of containment, and hydrogeology. If the flowchart indicates that a site poses a potential threat to human health or to the environment, the ranking model is applied. The model assigns a numerical score from 0 to 100 to each site. The score reflects the characteristics of the wastes, the potential migration pathways from the site, and possible contaminant receptors on and off the activity.

1.4.4 Site Ranking. After scoring a site, engineering judgment is applied to determine the need for a Confirmation Study or a mitigating action. At sites recommended for further work, CSRS scores are used to rank the sites in a prioritized list for scheduling projects. For a more detailed description, refer to NAVENENVSA Publication, Confirmation Study Ranking System (NEESA 20.2-042).



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Regional Map

FIGURE
1-1

1.4.5 Confirmation Study Criteria. A Confirmation Study is recommended for sites at which (1) sufficient evidence exists to indicate the presence of contamination, and (2) the contamination poses a potential threat to human health or to the environment.

1.5 CONFIRMATION STUDY. Generally, the EFD conducts the Confirmation Study in two phases--verification and characterization. In the verification phase, short-term analytical testing and monitoring determines whether specific toxic and hazardous materials, identified in the IAS, are present in concentrations considered to be hazardous. If required, a characterization phase, using longer-term testing and monitoring, provides more detailed information concerning the horizontal and vertical distribution of contamination migrating from sites, as well as site hydrogeology. If sites require remedial actions or additional monitoring programs, the Confirmation Study recommendations include the necessary planning information for the work, such as design parameters.

1.6 IAS REPORT CONTENTS. In this report, the significant findings, conclusions, and recommendations from the IAS are presented in Chapters 2 and 3. Chapter 4 describes general activity information, history, physical features, and biology. Chapters 5 through 8 trace the use of chemicals and hazardous materials, from storage and transfer, through manufacturing and operations, to waste processing and disposal. The later chapters provide detailed documentation to support the findings and conclusions in Chapter 2.

CHAPTER 2. SIGNIFICANT FINDINGS AND CONCLUSIONS

2.1 INTRODUCTION. This chapter summarizes the significant findings and conclusions made by the Initial Assessment Study (IAS) team concerning past disposal sites and potential contamination areas at Naval Weapons Center (NAVWPNCEN) China Lake. A total of 42 sites are identified and assessed in this IAS report. The locations of these sites are shown in Figures 2-1 through 2-4. Based on the evidence gathered in this study, fourteen (14) sites pose a potential threat to human health or the environment and therefore warrant confirmation studies. None of the sites are judged to pose an immediate threat, but the confirmation studies should be completed as soon as feasible to ensure potential impacts at the 14 sites are minimized. The scope of the confirmation studies and recommendations are discussed in Chapter 3. It is recommended that all 42 sites be annotated on NAVWPNCEN development maps so that future land use decisions can be regulated as appropriate.

This chapter begins with a summary discussion of hydrogeology and migration potential and potential contaminant receptors at NAVWPNCEN. Migration potential of pollutants is dependent on the physical characteristics of the site, the soil conditions, and the surface water and ground water system in the vicinity of the site. Following this discussion is a brief description of the disposal sites which are being recommended for confirmation studies. Finally, the sites not recommended for confirmation are described.

2.1.1 Hydrogeology and Migration Potential. This section presents a summary of the hydrogeologic conditions and migration potential at NAVWPNCEN China Lake.

The NAVWPNCEN China Lake community and the City of Ridgecrest are located in the Indian Wells Valley which serves as the drainage basin for the surrounding mountains. The major storm water washes which run through Ridgecrest and then through NAVWPNCEN originate in the El Paso Mountains to the southwest. Ridgecrest Wash and El Paso Wash drain to the China Lake Playa north of the NAVWPNCEN China Lake community.

Ground water in Indian Wells Valley occurs in two aquifers, a deep aquifer, which is the main water body, and a shallow aquifer. Recharge to these aquifers is in the form of precipitation that falls within the drainage areas of Indian Wells Valley, Rose Valley, and the Coso Basin. The Naval Weapons Center, Inyokern and Ridgecrest obtain potable water from the deeper, main aquifer.

The shallow aquifer lies above the deeper confined aquifer in the area surrounding China Lake Playa. The permeability of the shallow aquifer is less than the deep aquifer. However, ground water is being discharged from the shallow aquifer to the atmosphere through evapotranspiration. At the same time, the water from the deeper aquifer is migrating vertically upward to recharge the shallow aquifer.

The ground water flow system at China Lake is complicated due to a number of faults that act as barriers to ground water flow. The most important one at NAVWPNCEN is labeled the China Lake Barrier and is shown on Figure 2-2. It is reported (Dutcher, et al., 1974) that the ground water in the deep aquifer cannot flow across this barrier. Flow in the deep aquifer north and east of the barrier is migrating towards the China Lake Playa; flow south of the barrier is migrating towards the major pumping centers at Ridgecrest and at the Intermediate well field. These deep aquifer flow directions and receptors are shown on Figure 2-5.

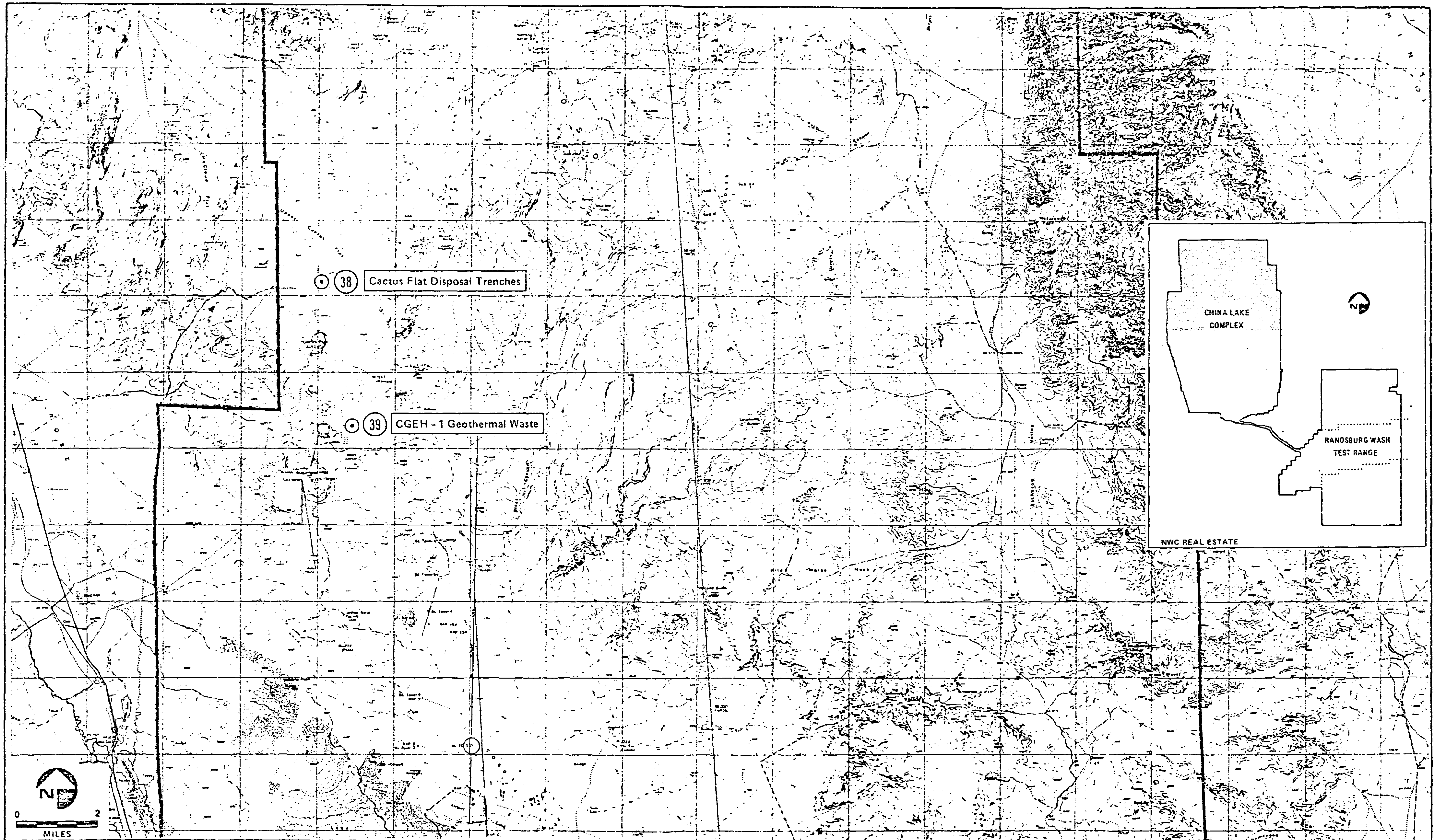
Flow in the shallow aquifer is toward the Playa north of the barrier. South of the barrier there is no shallow aquifer due to lack of recharge from the deep aquifer in this area. Man-made changes to the shallow ground water recharge system may cause changes in these patterns. For example, recharge from the wastewater evaporation ponds, irrigation of the golf course, and leaky sewers are causing local ground water mounds to occur. These mounds could rise high enough to cause a southerly component of flow in the shallow aquifer north of the barrier. In fact, there is concern that these changes in flow in this aquifer may cause shallow ground water to begin to flow across the barrier from north to south.

In addition to patterns of flow, the depth-to-water can affect the migration of contaminants. The depth to water at NAVWPNCEN varies widely from 2 to more than 200 feet. Thus, site specific analysis is needed for this parameter. The potential rate of contaminant migration, if directly linked with ground water flow, has been conservatively estimated (using worst case assumptions as discussed in Section 4.4.4.3) to be 0.27 feet per day or about 100 feet per year.

Recharge to the ground water body in the Mojave "B"/Randsburg Wash complex occurs by direct infiltration of rain, subsurface flow from the adjoining areas, and percolation of the infrequent runoff that occurs during flash floods from the surrounding mountains. Panamint Valley in the north Mojave "B" Range is a closed structural basin. Further description of this basin is given in Chapter 4 (Section 4.4.5), but is omitted here because no hazardous waste sites were identified in the area.

2.1.2 Potential Contaminant Receptors. The potential contaminant receptors of concern in the NAVWPNCEN area are: G-1 and Lark seeps with the ditch connecting them near and in the China Lake Playa; the public water supply wells south of the China Lake Barrier; and two individual wells north of the China Lake Barrier. These are shown on Figure 2-5. Of concern in the China Lake Playa area is the presence of the Mohave chub fish (*Gila bicolor mohavenis*), a federally-listed endangered species that was transplanted to Lark seep in 1970 from Soda Lake. The habitat for the chub is the G-1 and Lark seeps as well as the ditch that connects these seeps. Contaminant migration to this habitat has the potential to threaten this species. Contaminants discharged to the south of or near the China Lake Barrier would have the potential to enter the public drinking water supply which would pose a threat to human health. In addition, there are two wells, 7A and 22A, that are north of the Barrier that could be receptors of contaminant migration from disposal sites identified in this study. A potential threat to human health exists because these wells are or can be used for irrigation and potable water.

Salt Wells Valley, on the other hand, does not have a potable or agricultural water source. Ground water flow eventually moves toward Searles Lake which is a highly saline and is used as a mineral resource. No endangered species have been identified that could be affected by Salt Wells Valley or Searles Lake contaminant migration.



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NAVWPNCEN, CHINA LAKE

Site Location Map (North Section) Naval Weapons Center, China Lake

FIGURE 2-1

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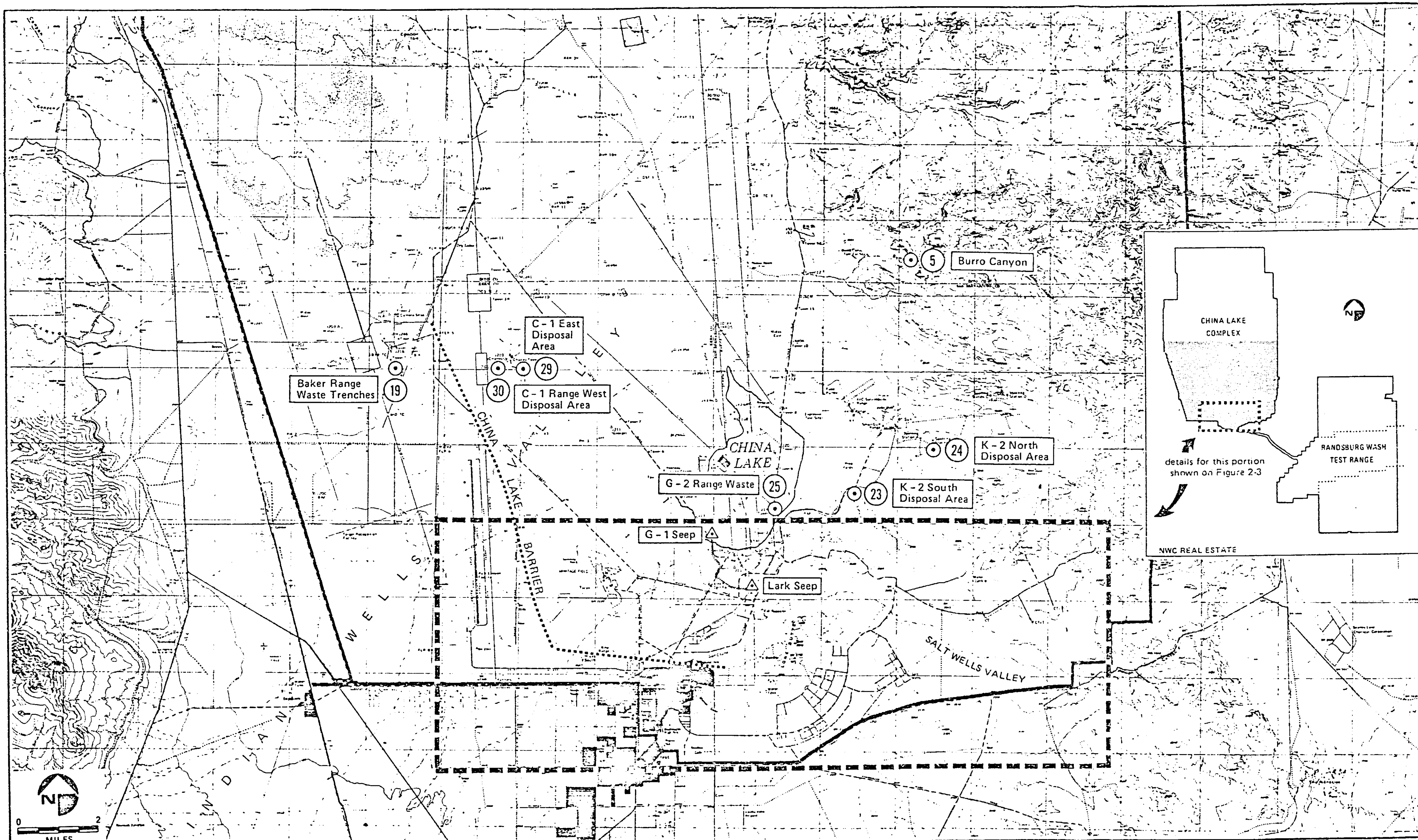

INITIAL ASSESSMENT STUDY
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Site Location Map (Central Section) Naval Weapons Center, China Lake

FIGURE 2-2

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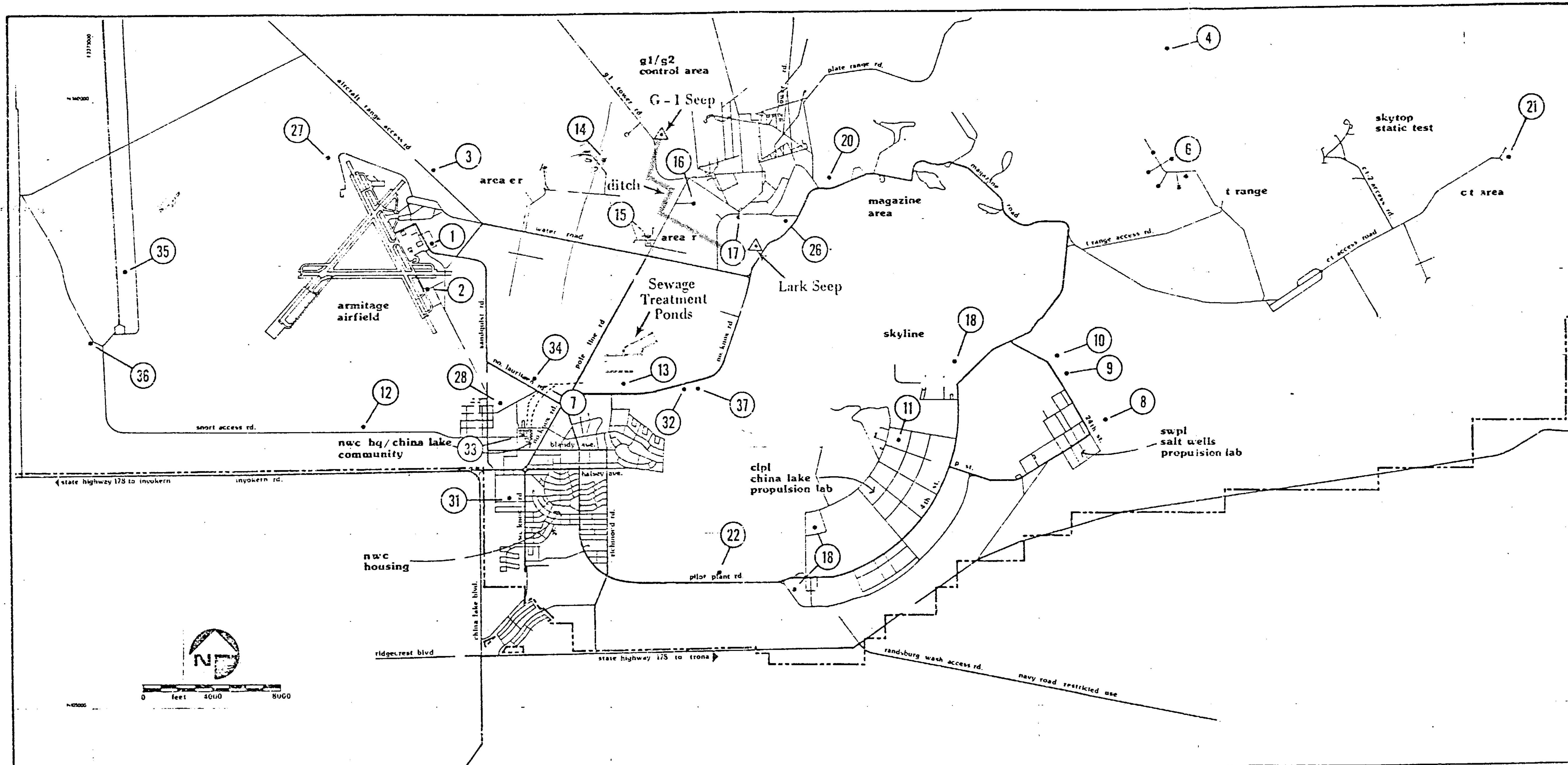

LEGEND:
Site Number & Name

1 Armitage Field Dry Wells
2 Aircraft Washdown Drainage Ditches
3 Armitage Field Leach Pond
4 Beryllium Contaminated Equipment Disposal Area
6 T-Range Disposal Area
7 Michelson Lab Drainage Ditches
8 Salt Wells Drainage Channels
9 Salt Wells Asbestos Trenches
10 Salt Wells Disposal Trenches
11 China Lake Propulsion Lab Evaporation Ponds
12 SNORT Road Landfill
13 Oily Waste Disposal Area
14 ER Range Septic System
15 R-Range Leach Field
16 G-1 Range Septic System
17 G-2 Range Septic System
18 CLPL Leach Fields
20 Divison 36 Ordnance Waste Area
21 CT-4 Disposal Area
22 Pilot Plant Road Landfill
26 G-Range Ordnance Waste
27 NAF Disposal Area
28 Old DPDO Storage Yard
31 Public Works Pesticide Rinse Area
32 Golf Course Pesticide Rinse Area
33 Michelson Lab Dry Wells
34 Lauritsen Road Landfill
35 Snort Track Accident
36 Snort Storage Sheds
37 Golf Course Landfill

INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site Location Map (South Section) Naval Weapons Center, China Lake

FIGURE 2-3

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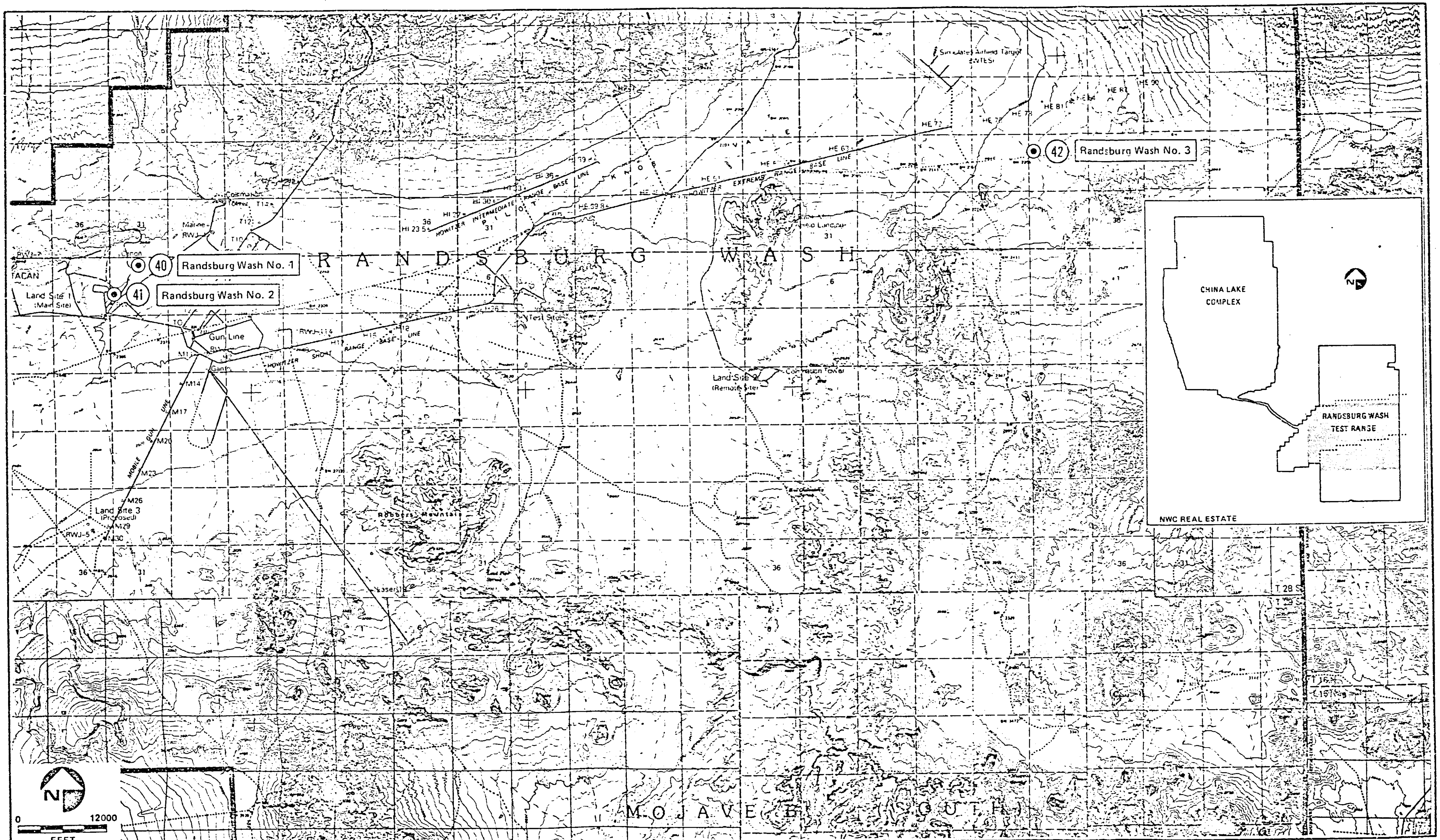

INITIAL ASSESSMENT STUDY
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Disposal Sites at Randsburg Wash

FIGURE 2-4

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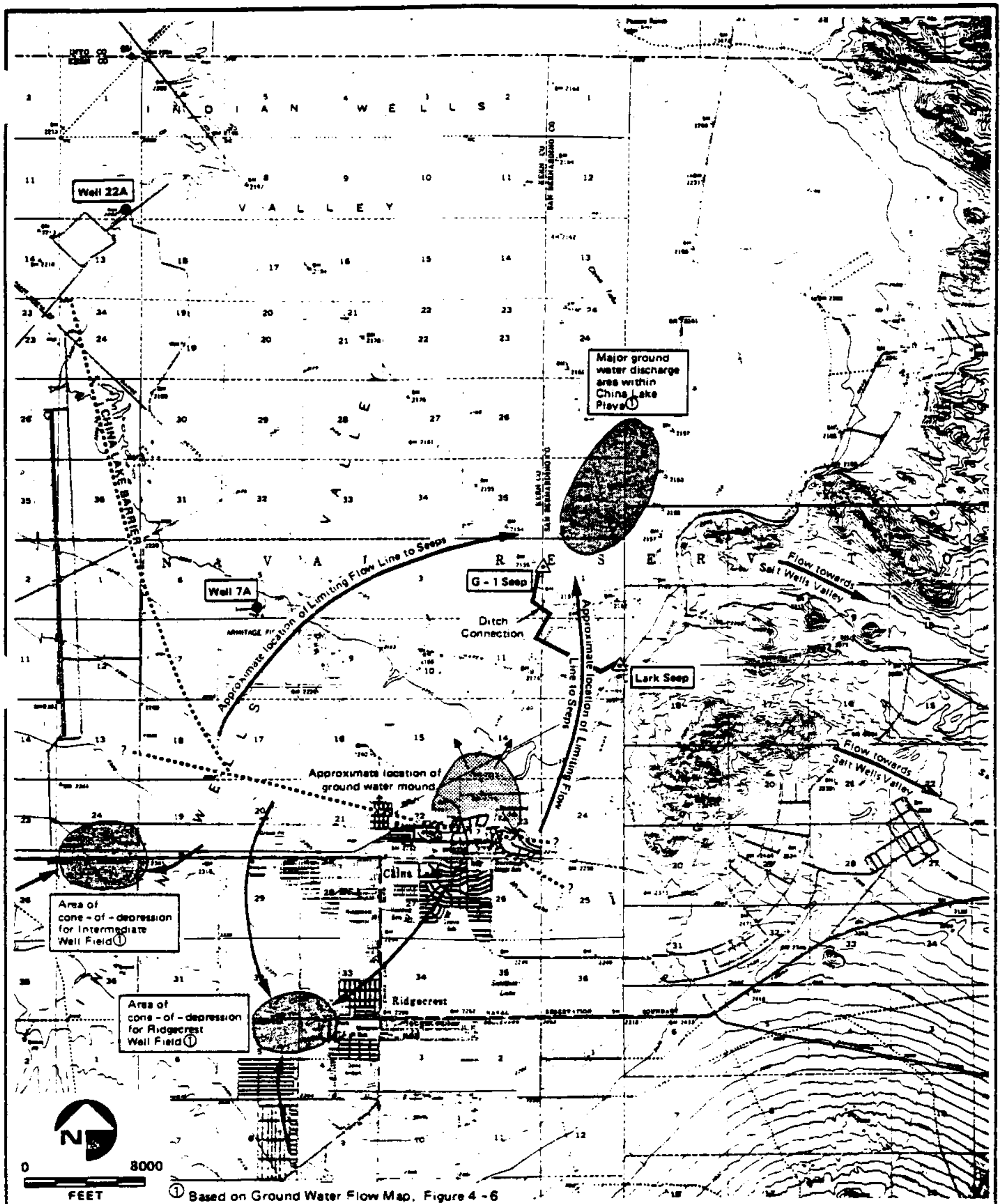

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Summary of Migration Pathways and Receptors

FIGURE 2-5

For Randsburg Wash, the IAS team identified no potential receptors (i.e. potable water sources or endangered species) which would be in the pathway of contaminant migration from known disposal sites.

2.2 SITES RECOMMENDED FOR CONFIRMATION STUDIES. Of the 42 disposal sites and potentially contaminated areas identified at NAVWPNCEN China Lake, 14 are recommended for confirmation studies. A brief description of each site is given below. Chapter 8 provides a more detailed discussion of all disposal sites.

2.2.1 <u>Site 3, Armitage Field Leach Pond</u>. From 1950 to 1981, sanitary and industrial wastes from Armitage Field operations were collected in a sewer which discharged to an Imhoff tank and then into an evaporation/leach pond (see Figure 2-3). The Imhoff tank was not effective at removing contaminants. The average flow to the pond was estimated to be about 17,000 gallons per day (gpd). Most of this volume was domestic sewage. About 500 gpd was washwater containing solvents such as trichloroethylene (TCE), detergents, oil and greases. Over 31 years it was estimated that about 20,000 gallons of these contaminants were discharged to the leach pond. Contaminants from the leach pond have the potential to migrate to the ground water, which is about 30 feet below the surface. The ground water migration pathway is to the north-northeast toward the G-1 seep which is about 2 miles away. Migration time (depending on gradients, hydraulic conductivities, and porosity) should range between 50 and 100 years. A confirmation study is recommended for this site because of the potential threat to the Mohave chub in the G-1 seep.

2.2.2 <u>Site 7, Michelson Lab Drainage Ditches</u>. From 1947 to 1981, chemical wastewaters up to 70,000 gallons per day were discharged from Michelson Lab to two open ditches. These ditches ran northeasterly toward the China Lake Playa. The western ditch was up to 3 miles long and emptied into an area just north of the sewage wastewater ponds. The ditches served plating/etching shops, photography shops, and various chemical research labs. Wastewaters contained acids, heavy metals, cyanides, and solvents such as TCE. Contaminants discharged near the laboratory are in an area where ground water mounding may cause the shallow aquifer to flow towards the south and thus in the direction of wells used for the public water supply. Contaminants discharged at the northern end of the ditches will migrate to the north towards the seeps which support the Mohave chub. Therefore, a confirmation study is recommended for this site.

2.2.3 <u>Site 12, SNORT Road Landfill</u>. From 1952 to 1979, solid waste from some NAVWPNCEN activities was disposed of in a landfill disposal site located on SNORT Track Road (see Figure 2-3). About 100 tons a year of Group 3 type wastes, such as tree trimmings, construction debris, barrels, plastics and rags, were deposited. In addition, some hazardous wastes including TCE, waste oils, unspecified chemicals and PCBs were disposed of in the landfill. Volumes could not be determined. The site contaminants have the potential to migrate to the ground water and in the direction of the public water wells in Ridgecrest. Therefore, a confirmation study is recommended.

2.2.4 <u>Site 13, Oily Waste Disposal Area</u>. From 1965 to 1980 waste oils, some solvents such as TCE, and greases were disposed of in two, unlined trenches located just south of the sewage treatment plant evaporation ponds (see Figure 2-3). Approximately 10,000 gallons of oily wastes were disposed of over the 15-year period. Ground water migration from this site has historically been to the north toward China Lake Playa and the G-1 seep, Lark seep, and the connecting ditch. However, because of the recharge from the adjacent evaporation ponds, the ground water flow may have shifted to the south. The distance to the seep area or to the water supply wells is less than 2 miles. Therefore, the potential exists for either the Mohave chub habitat or the public drinking water supply to be affected. A confirmation study is recommended.

2.2.5 Site 14, ER Range Septic System. From 1950 to 1981, the Anti-Radiation and Thompson Laboratory Buildings in the ER Range discharged industrial and sanitary wastes to five septic tanks. In 1981 the leach field for the septic system failed dictating the abandonment of the tanks. On the average 11,330 gallons per day of wastewater was discharged. This includes sanitary, cooling tower, and etching waste. Thirty gallons per day were etching wastewater. Over 31 years nearly 0.25 million gallons of etching wastewater was discharged. Depth to ground water is 10 feet and the contaminant migration flow may be towards the G-1 seep, which is less than 1 mile away. Therefore, a confirmation study for the site is recommended.

2.2.6 Site 15, R Range Septic System. From 1950 to 1980, industrial and sanitary wastes from the R Range Earth and Planetary Science Labs was discharged to five septic tanks apparently connected to one leach field. The average flow was 9530 gallons per day. Sixty gallons per day were solvent and photo lab contaminated wastewater. About 0.5 million gallons of this wastewater was discharged over 30 years. Flow from the site is to the north towards the ditch connecting the G-1 and Lark seeps which is less than 0.5 miles away. A confirmation study is recommended for this site.

2.2.7 Site 16, G-1 Range Septic System. Sanitary and photo lab wastewater from G-1 Range Buildings were discharged to 12 septic tanks. About 30 gallons per day was photo lab wastewater. Therefore, about 0.25 million gallons of contaminated wastewater was discharged. The system was abandoned in 1980 after being in use since 1950. Migration is towards the G-1 seep which is less than 1 mile away. An estimated travel time is 10 years. A confirmation study is recommended.

2.2.8 Site 17, G-2 Range Septic System. Sanitary wastes, explosive residue washwater and photo lab chemical wastes from the EOD Buildings in the G-2 Range were discharged to 3 septic tanks beginning around 1950. The system was abandoned in 1981. About 0.75 million gallons of wastewater contaminated by photo lab effluent and explosive residues of unknown type were discharged over these years. The waste streams are expected to be contaminated with metals (OESO, 1984). Migration is to the north towards the G-1 seep less than 1 mile away. The Lark seep is less than 1/2 mile to the south. A confirmation study is recommended.

2.2.9 Site 22, Pilot Plant Road Landfill. From 1944 to 1965, domestic waste from Navy family housing and some industrial/hazardous waste from the public works compound was disposed of in 12 large trenches north of Pilot Plant Road (see Figure 2-3). These wastes included oil and solvents, pesticides, paints, and thinners. Volumes could not be determined. The contaminants have the potential to migrate in the ground water to the main aquifer and toward the water supply wells less than 3 miles away. Therefore, a confirmation study is recommended.

2.2.10 Site 27, NAF Disposal Site. From 1945 to 1978, solid and liquid wastes generated by Armitage Naval Air Field (NAF) operations were disposed of in two or three trenches located west of the north end of the runways (see Figure 2-3). Waste materials included paints, solvents (TCE), oils and grease, and Group-3 type wastes such as wood, concrete, glass, and rags. The migration pathway is toward China Lake Playa but not towards the seeps. However, there is a well (7A) less than 0.5 miles southeast that could draw contamination towards it if pumped extensively in the future. Therefore, a confirmation study is recommended for the site.

2.2.11 Site 29, C-1 East Disposal Area. From 1950 to 1979, inert range wastes, and reportedly live ordnance and chlordane were buried in a 3-trench disposal site east of C-1 Range Tower (see Figure 2-2). An estimated 17,000 gallons of chlordane, of the same type as that found in Site 23, were buried here in unopened containers. A water well (22A) used for irrigation and potable water is located 0.25 miles away that could draw the chlordane towards it and cause contamination. A confirmation study is recommended to verify the presence of chlordane and to determine the migration potential of this contaminant.

2.2.12 Site 31, Public Works Pesticide Rinse Area. From 1945 to 1980, pesticide rinse water of various concentrations was spilled onto the soil in an area behind the public works compound (see Figure 2-3). Pesticides included Malathion, DDT, Chlordane, Diazanone, and Vapoma among other non-agricultural types. An estimated 2000 gallons of this rinse water were spilled each year. If 1 percent was pesticide then over 35 years it is estimated that 700 gallons of pesticide may have been discharged. The site is located over the main aquifer and is within 1.5 miles of the public water wells. The ground water migration potential is in the direction of these wells. Therefore, a confirmation study for this site is recommended.

2.2.13 Site 32, Golf Course Pesticide Rinse Area. From the mid 1960's until 1980, pesticide rinsing also took place at a location on the golf course (see Figure 2-3). An estimated 150 gallons of pesticide was spilled over 15 years. The direction of ground water at this site could be either north towards the G-1 and Lark seeps (2-3 miles) or south to the public water wells (3-4 miles). A confirmation study is recommended to determine the migration direction and presence of contamination.

2.2.14 Site 34, Lauritsen Road Landfill. From 1944 to 1955, solid wastes and liquid hazardous wastes were disposed of in several trenches located just north of Lauritsen Road (see Figure 2-3). The wastes include Group-3 type materials, and solvents, pesticides, lab chemicals and oils. Volumes and specific chemicals could not be determined. Because of the site location relative to the ground water barrier the contaminant migration could either be north toward the G-1 seep or to the south toward the water supply wells. A confirmation study is recommended for verifying the direction of ground water flow and determining if contaminants are present in the flow.

2.3 NON-CONFIRMATION STUDY SITES. Of the 42 disposal sites identified, 28 sites do not need confirmation studies. These sites are described below.

2.3.1 Site 1, Armitage Field Dry Wells. From 1945 to 1982, substandard JP-4 and JP-5 fuels were disposed of into 6 dry wells at the fuel farm. An estimated

1,000,000 gallons of fuel were discharged to the wells over the 37 year period. Previous hydrogeologic studies (Ertec, 1982; Leedshill, 1983) commissioned by NAVWPNCEN confirmed ground water contamination. Funding has been authorized for a remedial action program which is currently being planned. Therefore, no further action under the NACIP program is warranted for this site.

2.3.2 Site 2, Aircraft Washdown Drainage Ditches. From 1945 to 1982, aircraft washwater containing oils and TCE were disposed of in two unlined-open ditches (see Figure 2-3). Previous well borings in the ditches have confirmed the presence of fuel and TCE contaminants in the ground water (Leedshill-Herkenhoff, 1983). This site is included in the remedial action plan being carried out for site 1 and therefore no further action under the NACIP program is necessary.

2.3.3 Site 4, Beryllium Contaminated Equipment Disposal Area. In the early 1960s, beryllium-contaminated equipment from the Salt Wells Lab area was burned and buried in an area 5-6 miles northeast of the labs (see Figure 2-3). An estimated 900 cubic yards of scrap equipment and materials were buried. The amount of beryllium residue remaining after the burn could not be determined in this study. Noting that beryllium is highly adsorbed in the soil and that the water table is more than 100 feet deep, the migration potential of beryllium residue is very minimal. Ground water migration is in the direction of Salt Wells Valley. There are no sensitive receptors or potable water sources in Salt Wells Valley. No confirmation study is needed for this site.

2.3.4 Site 5, Burro Canyon. From 1968 to 1979, hazardous chemicals were brought to Burro Canyon (see Figure 2-2) and burned with PEP materials. Burro Canyon was commonly used to burn PEP materials such as TNT, compound B, and vinyl compounds. The site continues to be used for disposal of PEP materials but other hazardous chemicals are no longer brought to the site. Depth to bedrock is 300 feet and the water table is below the bedrock interface. Migration potential of contaminant residue would be from surface flooding with transport toward China Lake Playa. However, infrequent flooding of the site would result in very low concentrations of contaminanted water, and flood waters reaching the Playa would have a very low potential of contaminating the local ground water system or the seeps. Therefore, no confirmation studies are recommended for this site.

2.3.5 Site 6, T-Range Disposal Area. The T-Range disposal area is currently in operation, however, prior to 1975 hazardous PEP materials from Salt Wells Lab were burned in this area and buried in nine slit trenches. Ground water is more than 100 feet below surface and migration is towards Salt Wells Valley. The potential migration of residue contaminants is highly unlikely; however, if contaminants were to reach the Salt Wells Valley ground water system, flow would continue to Searles Lake. Attenuation through adsorption and dilution would be high. Thus, migration would not pose a threat to human health or the environment. Therefore, a confirmation study is not recommended.

2.3.6 Site 8, Salt Wells Drainage Channels. From 1946 to 1981, chemical wastes and explosive material washwaters (containing ammonium perchlorate, TNT, isocyanates) were discharged from Salt Wells Labs to open unlined drainage channels. Lined ponds were installed in 1981. Depth to ground water is about 150 feet. Migration potential to this water zone is low and the direction of flow is toward Salt Wells Valley. Therefore, the contaminant migration poses no threat to human health or the environment. No further action is recommended for this site.

2.3.7 Site 9, Salt Wells Asbestos Trenches. From 1979 to 1981, 300 cubic yards of asbestos was buried in three trenches north of Salt Wells Lab area (see Figure 2-3). Asbestos does not migrate in the soil and therefore would not reach ground water, which is 150 feet below the surface. A confirmation study is not recommended for this site.

2.3.8 Site 10, Salt Wells Disposal Trenches. From 1960 to 1980, all solid wastes and some liquid hazardous wastes from Salt Wells and China Lake Propulsion Labs were disposed of in 10 trenches. Wastes included construction debris, TCE, and liquid chemicals. As is the case with all Salt Wells sites, the migration potential of contaminants is toward Salt Wells Valley and possibly on to Searles Lake. Therefore, no confirmation study is needed.

2.3.9 Site 11, China Lake Propulsion Lab Evaporation Ponds. Wastewater contaminants containing RDX, AP, and some aluminum metal filings were reported to be discharged from two CLPL buildings to two unlined evaporation ponds (Dodohara and Davis, 1979). This operation may have occurred from 1946 until 1981 when the ponds were replaced by new, clay-lined ponds. Due to the long distances to a potential receptor, the depth to ground water, and the high potential of attenuation from adsorption, dilution, and dispersion of these chemicals, no confirmation study is recommended.

2.3.10 Site 18, China Lake Propulsion Laboratory Leach Fields. From 1950 to 1981, wastewater contaminated with phosphates, sodium sulfide, RDX, TNT, TCE, greases, and photo lab chemicals from the CLPL buildings was discharged to three septic tanks with three different leach fields. In 1981 one leach field was abandoned and two were rehabilitated. The depth to water is 100-300 feet, and the nearest water supply wells are 5-6 miles away. Contaminant migration will be attenuated by adsorption and dilution over the long distances and depths. Therefore, no confirmation study is recommended.

2.3.11 Site 19, Baker Range Waste Trenches. From 1944 to 1983, inert range wastes from Baker Range were disposed of in one trench (450 x 25 x 10 feet) (see Figure 2-2). The wastes consisted of range target debris, wood, scrap metal, concrete and electronic parts. No ordnance or hazardous wastes were included in this disposal. Ground water is more than 50 feet deep and flows toward China Lake Playa. Due to the inert nature of materials no confirmation study is recommended.

2.3.12 Site 20, Division 36 Ordnance Waste Area. From 1960 to 1979 range and inert ordnance wastes, such as target materials and bomb casings, were disposed of in two slit trenches in the Division 36 area (see Figure 2-2). Volume is estimated at 600 cubic yards. The wastes are inert and contain no hazardous contaminants. Therefore, a confirmation study is not recommended.

2.3.13 Site 21, CT-4 Disposal Area. From 1956 to 1979, special weapons testing wastes from CT Ranges were disposed of in a large ditch (200 x 50 x 10 feet) adjacent to CT Access Road (see Figure 2-2). Wastes included PEP materials, depleted uranium, radium dials, solvents, oils, and construction debris. About 2000 cubic yards were disposed. Ground water is at a depth of 100 feet or more.

Migration is towards Salt Wells Valley. Migration potential does not pose a threat to human health or to the environment. Therefore confirmation studies are not recommended.

2.3.14 Site 23, K-2 South Disposal Area. Between 1950 and 1981, range wastes from K-2 Range were disposed of in two slit trenches (see Figure 2-2). The wastes included construction and range demolition debris, bomb casings, concrete, and wood. Reportedly, about 17,000 gallons of chlordane, which is now a federally banned pesticide, were also buried. The chlordane was in unopened 1- and 5-gallon metal cans when buried. Migration potential is towards China Lake Playa but contamination cannot reach the seeps or public water supply. Therefore, no receptor has been identified and thus no confirmation study is recommended.

2.3.15 Site 24, K-2 North Disposal Area. Between 1950 and 1981 inert range wastes, such as target debris and bomb casings, were disposed of in two slit trenches located in the northern K-2 Range (see Figure 2-2). Volume was about 500 cubic yards. The wastes are inert and, therefore, confirmation studies are not recommended.

2.3.16 Site 25, G-2 Range Disposal Area. From 1944 to 1958 inert range wastes, such as concrete, wood, metal, and bomb casings, were buried in 3 slit trenches located in the G-2 Range (see Figure 2-2). Volume was about 600 cubic yards. No waste migration potential exists and therefore a confirmation study is not recommended for this site.

2.3.17 Site 26, G Range Ordnance Waste Area. From 1950 to 1979 inert range wastes, including target debris and bomb casings, were buried in two slit trenches located on the north end of G Range (see Figure 2-2). Volume was about 500 cubic yards. As the wastes are inert no confirmation study is recommended.

2.3.18 Site 28, Old DPDO Storage Yard. From 1965 to 1970, a Defense Property Disposal Office (DPDO) was located on Iwo Jima Road (see Figure 2-3). This site, reportedly, was used to store transformers containing PCBs. However, no evidence was found to substantiate PCB spills. No other potential contaminants were identified for this site. Therefore, no confirmation study is recommended.

2.3.19 Site 30, C-1 Range West Disposal Area. From 1950 to 1979, inert range waste and reportedly some live ordnance was buried in two slit trenches located west of C-1 Range Tower (see Figure 2-2). Access to this area is properly regulated. No contamination capable of migration has been identified. Therefore, a confirmation study is not recommended.

2.3.20 Site 33, Michelson Lab Dry Wells. From 1950 to the 1970s, there were four unlined dry wells at Michelson Lab. The wells, which have been either closed or filled in, were located between the east wings of Building 00005 (see Figure 2-3). The wells were connected to drains in the floors of auxiliary power rooms where large batteries were kept. These batteries were sometimes drained or they leaked onto the floor and thus into the drains and dry wells. The rooms and drains were designed for that use only. Research did not reveal an indication that these wells were used for any other purpose or other chemicals. The volume of acid is reported to be less than 10 gallons per year and the contamination potential from sulfuric acid is minimal as it does not migrate through soil very well. A confirmation study is not recommended for the site.

2.3.21 Site 35, SNORT Track Accident. In 1961, a projectile containing about 4 pounds of beryllium accidently exploded in the gun barrel of artillary test equipment. The site is located alongside the SNORT Tract about 3000 feet from the south end (see Figure 2-2). The beryllium contaminated equipment was buried at that site. Ground water is located at a depth of 100 feet. The potential for contaminant migration is low and, therefore, a confirmation study is not recommended.

2.3.22 Site 36, SNORT Track Storage Sheds. From 1956 to 1962 hazardous chemicals were stored and occassionally spilled at storage sheds located near the south end of the SNORT Track. Chemicals included nitric acid, unsymmetrical dimethyl hydrazene, and analine. The volume of all spills was reported to be less than 300 gallons, much of which either evaporated or was adsorbed in the surface soils. Ground water is at a depth of 100 feet and the potential for contaminant migration is low. Therefore, no confirmation study is recommended for this site.

2.3.23 Site 37, Golf Course Landfill. From 1945 to 1965, general refuse and construction/demolition debris were disposed of in a landfill adjacent to the NAVWPNCEN golf course. About 1200 cubic yards were disposed. The wastes pose no potential contamination problem and therefore a confirmation study is not recommended.

2.3.24 Site 38, Cactus Flat Disposal Trenches. From 1968 to 1979, solid wastes including wood, concrete, cans, and metal casings, were disposed of in several trenches located in the Cactus Flat area. No hazardous wastes have been identified and therefore a confirmation study is not recommended.

2.3.25 Site 39, CGEH-1 Geothermal Waste. In the 1970s, geothermal drilling muds and oil wastes were disposed of in an open pit in the Coso Range (see Figure 2-1). The site was properly closed in 1979. Ground water either does not occur in this area or is very deep. It has been determined that contamination migration would not reach ground water in any detectable amounts. Therefore no confirmation study is recommended.

2.3.26 Site 40, Randsburg Wash #1. From 1950 to 1975, inert ordnance and range wastes were disposed of in three trenches located at Randsburg Wash (see Figure 2-4). Since the wastes contain no hazardous contaminants, migration potential is not a concern. No confirmation study is recommended.

2.3.27 Site 41, Randsburg Wash #2. From 1950 to 1980, general Group 3-type wastes, electronic equipment, solvents, oils and paints were disposed of in two trenches located northeast of the Randsburg Wash administration area (see Figure 2-4). Approximately 4000-6000 total gallons of motor oil, kerosene, TURCO, and acetone were disposed at this site. The waste pile was regularly burned before being buried. Depth to ground water is 250 feet. It is highly unlikely that waste contaminants would reach the ground water due to the burning process and soil attenuation. Furthermore, the transmissivity is very low making contaminant transport extremely slow. While water wells exist 1-2 miles southeast of the site the ground water gradient appears to slope to the northwest. Therefore, no confirmation study is recommended.

2.3.28 Site 42, Randsburg Wash #3. In the 1970s, about 30 partially full, 55-gallon drums of mixed fuels were burned and partially buried in a pit east of the Randsburg Wash administration area (see Figure 2-4). It is assumed that most of the fuel was burned and there is no visible evidence of fuel residue in the soil at this site. Ground water is at a depth of 250 feet and contaminant migration to this level is not probable. Therefore, no confirmation study is recommended for this site.

CHAPTER 3. RECOMMENDATIONS

3.1 INTRODUCTION. This chapter presents recommendations for the 42 disposal and spill sites identified at NAVWPNCEN China Lake. Fourteen sites pose a potential threat to human health or the environment and are recommended for confirmation studies. The Confirmation Study Ranking System (CSRS) is used to systematically evaluate the severity of potential problems at these sites. Two sites are recommended for no further action under the NACIP program due to the fact that confirmation type studies have already occurred and remedial action is being implemented. The remaining 26 sites are recommended for no further action because they pose no threat to human health or the environment. However, it is recommended that all sites be annotated on NAVWPNCEN development maps for future consideration in land development decisions. Table 3-1 summarizes these recommendations.

The sampling recommendations discussed in this chapter are designed to first verify the presence of contamination. Ground water samples from monitoring wells, for example, are generally recommended to be collected quarterly for a period of 1 year. Depending on results of the first year verification, a further characterization of the extent of the contamination at the sites may be required. Design of the characterization study would depend on results from the verification work.

3.2 CONFIRMATION STUDIES. The IAS team concluded that confirmation studies are appropriate and warranted for 14 sites. The results of the CSRS and a summary of the recommended actions for these sites are provided in Table 3-2. The sites have been recommended primarily because of the potential to contaminate the public water supply or adversely affect an endangered fish species (Mohave chub) located in the area of the seeps in or near China Lake Playa. Tables 3-3 and 3-4 define the acronyms and methods used in Table 3-2 and in the site recommendations discussed in the rest of this chapter. For some sites the exact direction of ground water movement is not known. Therefore the direction has been approximated using the best available information and the monitoring wells have been located appropriately. These wells will be used to verify contamination and ground water flow directions. After interpreting data from these wells, it may be determined that further characterization of the ground water flow system is necessary. At that time additional studies may be recommended.

3.2.1 Site 3, Armitage Field Leach Pond.

Type of Samples:	Ground water Soil
Number of ground water monitoring wells:	4 wells approximately 30 feet deep, 20-foot casing/10-foot screen
Number of soil samples:	10 soil samples in abandoned pond
Frequency of Sampling:	Water: quarterly for 1 year Soils: once

Table 3-1

Summary of Site Recommendations

Site Number	Site Name	Recommendations
60-1	Armitage Field Dry Wells	No further action under NACIP program. Remedial action being planned.
60-2	Aircraft Washdown Drainage Ditches	No further action under NACIP program. Remedial action being planned.
60-3	Armitage Field Leach Pond	Confirmation
60-4	Beryllium Contaminated Equipment Disposal Area	No further action
60-5	Burro Canyon	No further action
60-6	T-Range Disposal Area	No further action
60-7	Michelson Laboratory Drainage Ditches	Confirmation
60-8	Salt Wells Drainage Channels	No further action
60-9	Salt Wells Asbestos Trenches	No further action
60-10	Salt Wells Disposal Trenches	No further action
60-11	China Lake Propulsion Lab Evaporation Ponds	No further action
60-12	SNORT Road Landfill	Confirmation
60-13	Oily Waste Disposal Area	Confirmation
60-14	ER Range Septic System	Confirmation
60-15	R-Range Leach Field	Confirmation
60-16	G-1 Range Septic System	Confirmation
60-17	G-2 Range Septic System	Confirmation
60-18	China Lake Propulsion Lab Leach Fields	No further action
60-19	Baker Range Waste Trenches	No further action
60-20	Division 36 Ordnance Waste Area	No further action

Table 3-1

Summary of Site Recommendations (Continued)

Site Number	Site Name	Recommendations
60-21	CT-4 Disposal Area	No further action
60-22	Pilot Plant Road Landfill	Confirmation
60-23	K-2 South Disposal Area	No further action
60-24	K-2 North Disposal Area	No further action
60-25	G-2 Range Disposal Area	No further action
60-26	G-Range Ordnance Waste Area	No further action
60-27	NAF Disposal Area	Confirmation
60-28	Old DPDO Storage Area	No further action
60-29	C-1 East Disposal Area	Confirmation
60-30	C-1 Range West Disposal Area	No further action
60-31	Public Works Pesticide Rinse Area	Confirmation
60-32	Golf Course Pesticide Rinse Area	Confirmation
60-33	Michelson Laboratory Dry Wells	No further action
60-34	Lauritsen Road Disposal Area	Confirmation
60-35	SNORT Track Accident	No further action
60-36	SNORT Storage Sheds	No further action
60-37	Golf Course Landfill	No further action
60-38	Cactus Flat Disposal Trenches	No further action
60-39	CGEH-1 Geothermal Waste	No further action
60-40	Randsburg Wash #1	No further action
60-41	Randsburg Wash #2	No further action
60-42	Randsburg Wash #3	No further action

Table 3-2

Summary of Confirmation Study Sites Recommendations

Site Number	Site Name	CSRB Score	Number of Wells	First Year Sampling	Sampling Frequency	Parameters to be Analyzed*
60-3	Armitage Field Leach Pond	8	4	16 ground water 10 soil	Water: quarterly Soil: once	Water: PIGWQ, EPA 601, 602, 624, 625 Soil: PIGWQ, EPA 3550, 8270 and 8240
60-7	Michelson Lab Drainage Ditches	9	4	16 ground water 26 soil	Water: quarterly Soil: once	PIGWQ, metals in IPDWS, copper, nickel, EPA 601 and 602
60-12	SNORT Road Landfill	8	4	16 ground water	Quarterly	PIGWQ, EPA 601, 602, and PCB
60-13	Oily Waste Disposal Area	6	4	16 ground water 3 soil	Water: quarterly Soil: once	Water: oil, PIGWQ Soil: oil
60-14	ER Range Septic System	3	4	16 ground water 5 soil	Water: quarterly Soil: once	PIGWQ, IPDWS, EPA 601 and 602
60-15	K Range Leach Field	3	4	16 ground water 5 soil	Water: quarterly Soil: once	PIGWQ, EPA 601 and 602
60-16	G1 Range Septic System	5	4	16 ground water 2 soil	Water: quarterly Soil: once	PIGWQ, silver, chromium
60-17	G2 Range Septic System	3	4	16 ground water 3 soil	Water: quarterly Soil: once	PIGWQ, metals in IPDWS, EPA 601, and and 602
60-22	Pilot Plant Road Land-fill	10	4	16 ground water	Quarterly	PIGWQ, EPA 601, 602, 608, 624, 625 and metals in IPDWS
60-27	NAF Disposal Area	3	4	16 ground water	Quarterly	PIGWQ, metals in IPDWS, EPA 624 and 625
60-29	C-1 East Disposal Area	12	4	16 ground water	Quarterly	Chlordane, EPA 601, 602, 608, 624 and 625
60-31	Public Works Pesticide Rinse Area	10	0	10 soil	Soil: once	Pesticides (EPA 608)
60-32	Golf Course Pesticide Rinse Area	5	0	10 soil	Soil: once	Pesticides (EPA 608)
60-34	Lauritsen Road Disposal Area	3	4	16 ground water	Quarterly	PIGWQ, EPA 601, 602, 608, 624, 625, metals in IPDWS

*Parameters indicated by acronyms are defined on Table 3-3.

Table 3-3

Acronyms Used for Parameters to be Analyzed

Acronym	Name	Compounds
IPDWS	Interim Primary Drinking Water Standards	Enderin, Lindane, Methoxychlor, Toxaphine, 2,4 Dinitrotoluene, 2,4,5 Trichlorophenoxy, Radium, gross alpha and beta, Arsenic, Barium, Cadmium, Chromium, Flourine, Lead, Mercury, Nitrate, Selenium, Silver
PIGWQ	Parmeters Used as Indicators of Ground Water Quality	pH, Specific Conductance, Total Organic Carbon, Total Organic Halogen

Table 3-4

EPA Methods Defined*

Method Number	Parameters Tested
624	GC/MS Volatile Screen for Water
625	GC/MS Semi-Volatile Screen for Water
3550, 8270	GC/MS Semi-Volatile Screen for Soils
8240	GC/MS Volatile Screen for Soils
608	Pesticides
602	Aromatic Solvents
601	Halogenated Solvents

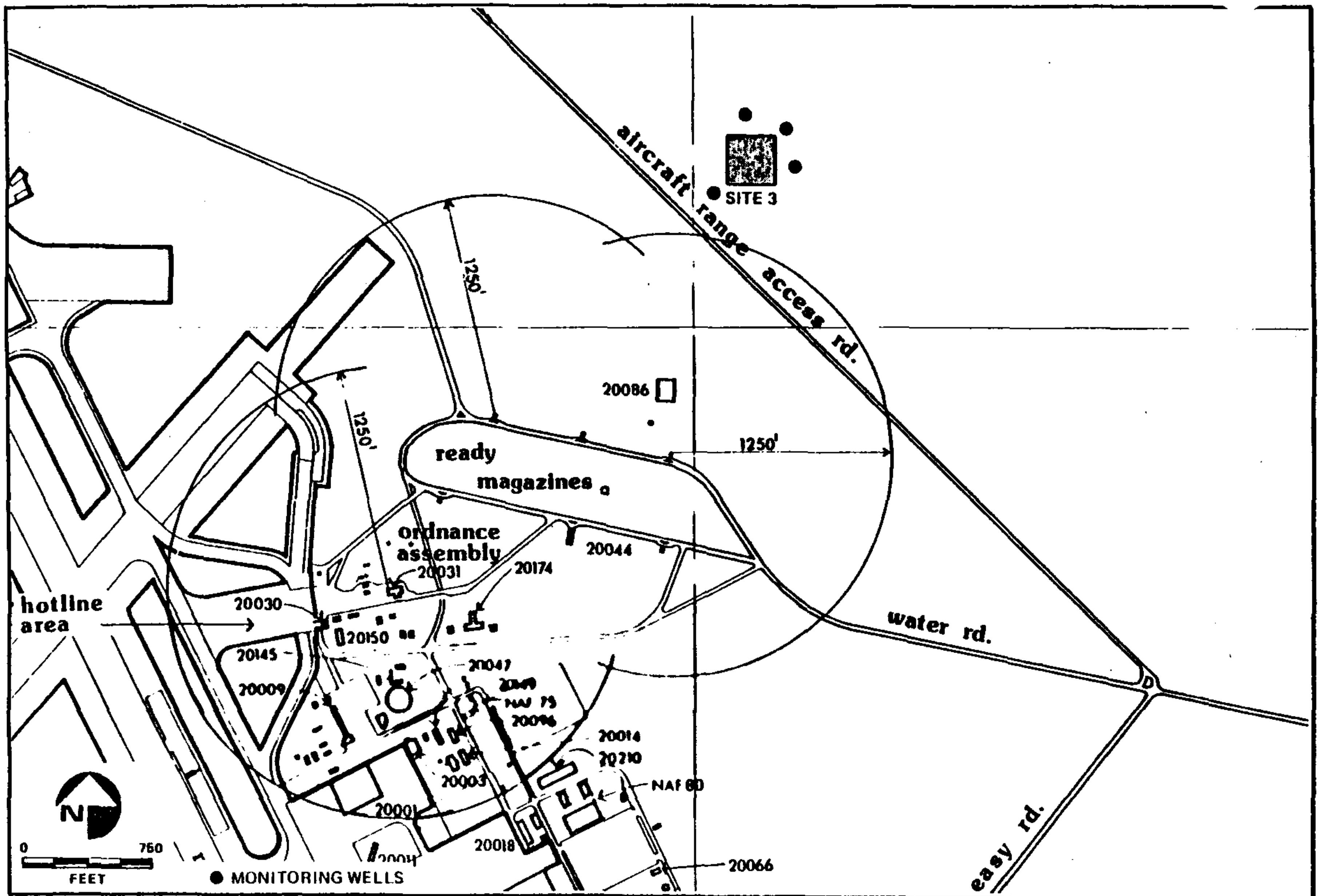
*EPA Publication SW-846, 2nd edition.

Number of Samples:	16 water 10 soil
Testing Parameters:*	Water: PIGWQ, EPA 601, 602, 624, 625, water levels Soil: PIGWQ, EPA methods 3550, 8270 and 8240
Remarks:	A total of four wells, three down gradient and one upgradient of the pond should be installed with a hollow stem auger. Wells should be screened in the interval from about 20 to 30 feet below land surface. Soil samples should be taken from 0-2 feet in the pond area and composited for analysis. Suggested well locations are shown on Figure 3-1.

*See Table 3.3 for acronym definition.

3.2.2 Site 7, Michelson Lab Drainage Ditches.

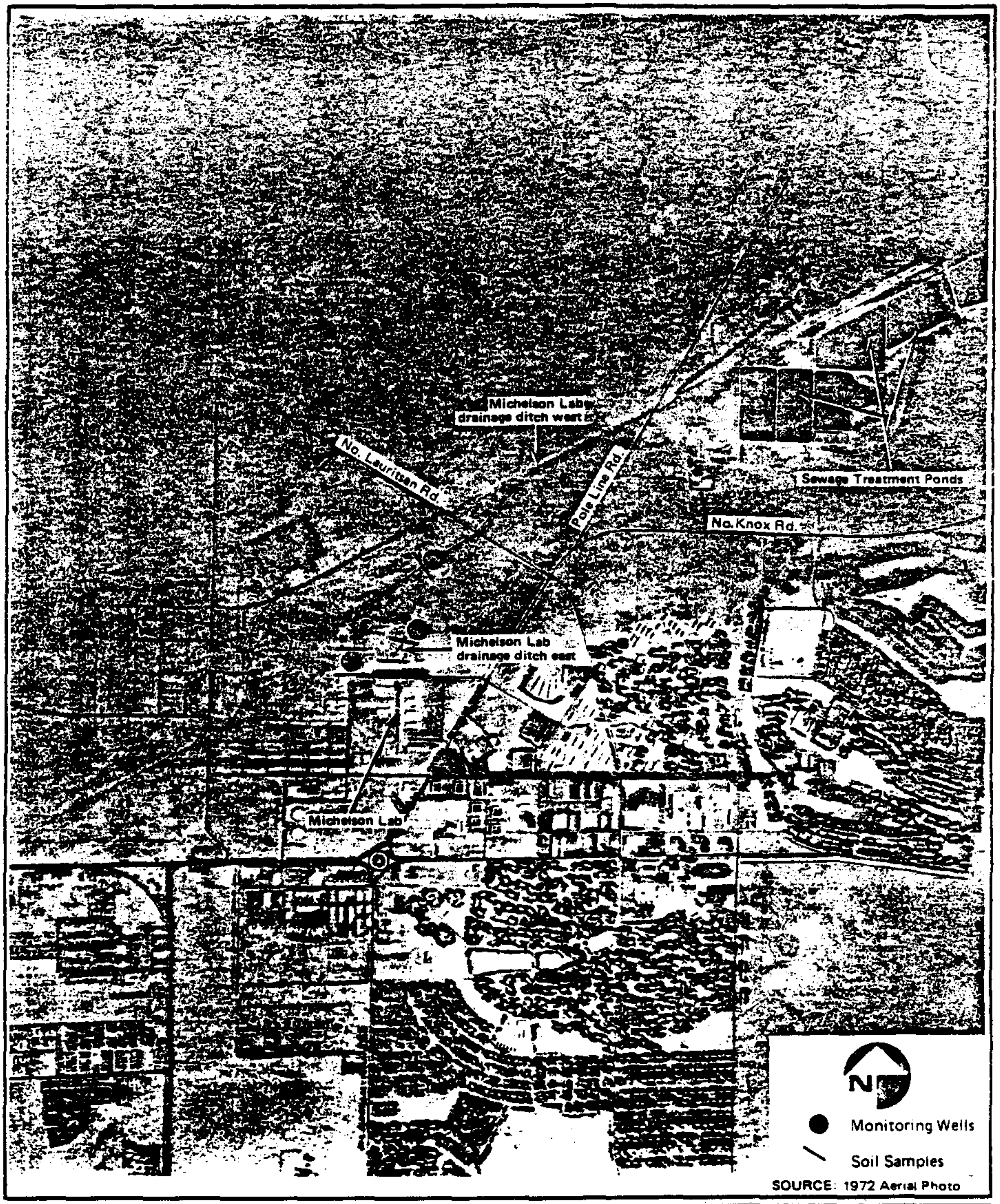
Type of Samples:	Ground water Soil
Number of ground water monitoring wells:	Four wells, 25 feet deep, screen 10 feet, casing 15 feet.
Number of soil samples:	5 samples per well and 6 soil samples from the ditches.
Frequency of Sampling:	Water: quarterly for 1 year Soil: once
Number of Samples:	16 ground water 26 soil
Testing Parameters:	PIGWQ, metals in IPDWS, copper, nickel, EPA 601 and 602, water levels in wells
Remarks:	Four wells, three along the west ditch and one in the east ditch are recommended. Soil samples should be taken every 5 feet and analyzed. The wells should be screened from 15 to 25 feet below land surface. In addition, six surface soil samples from the ditches should also be taken and analyzed. Detection limits should be based on regulatory criteria. The suggested locations for the wells and soil samples are shown on Figure 3-2.



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 3, Armitage Field Leach Pond Confirmation Study

FIGURE 3-1



SOURCE: 1972 Aerial Photo

INITIAL ASSESSMENT STUDY NAVWPNCEN, CHINA LAKE	Site 7, Michelson Lab Drainage Ditches Confirmation Study	FIGURE 3-2

3.2.3 Site 12, SNORT Road Landfill.

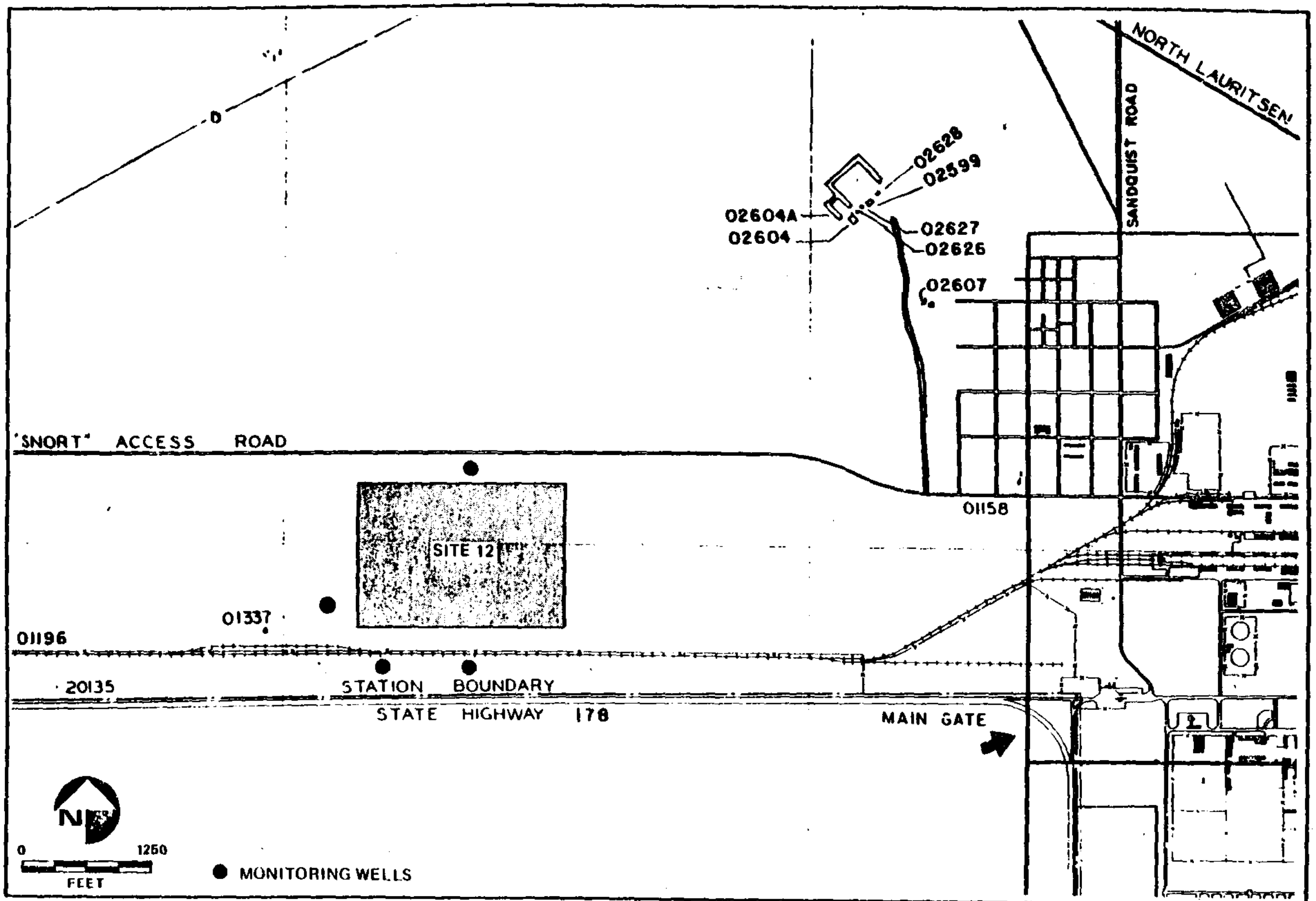
Type of Samples:	Ground water
Number of ground water monitoring wells:	Four wells about 120 feet deep (100 to water and 20 feet of screen)
Frequency of Sampling:	Quarterly for 1 year
Number of Samples:	16
Testing Parameters:	PIGWQ, EPA 601, 602, PCB, water levels
Remarks:	A total of four wells, three down gradient and one upgradient of the site should be installed. Wells should be screened from about 100-120 feet below land surface. Figure 3-3 depicts suggested well locations.

3.2.4 Site 13, Oily Waste Disposal Area.

Type of Samples:	Ground water Soil
Number of ground water monitoring wells:	4 wells 30 feet deep with screen from 20 to 30 feet
Number of soil samples:	1 boring in trench with samples at 10, 15, and 20 feet
Frequency of Sampling:	Ground water: quarterly for 1 year Soil: once
Number of Samples:	Ground water: 16 Soil: 3
Testing Parameters:	Soil: Oil Ground water: Oil, PIGWQ, water levels
Remarks:	Soil samples should be taken in disposal area from a single boring at 3 levels. Four wells, three downgradient and one upgradient of the disposal site should be installed with hollow stem auger. The direction of ground water movement will be studied as part of the verification program. Figure 3-4 shows the recommended approach using the best estimate that ground water is moving north.

3.2.5 Site 14, ER Range Septic System.

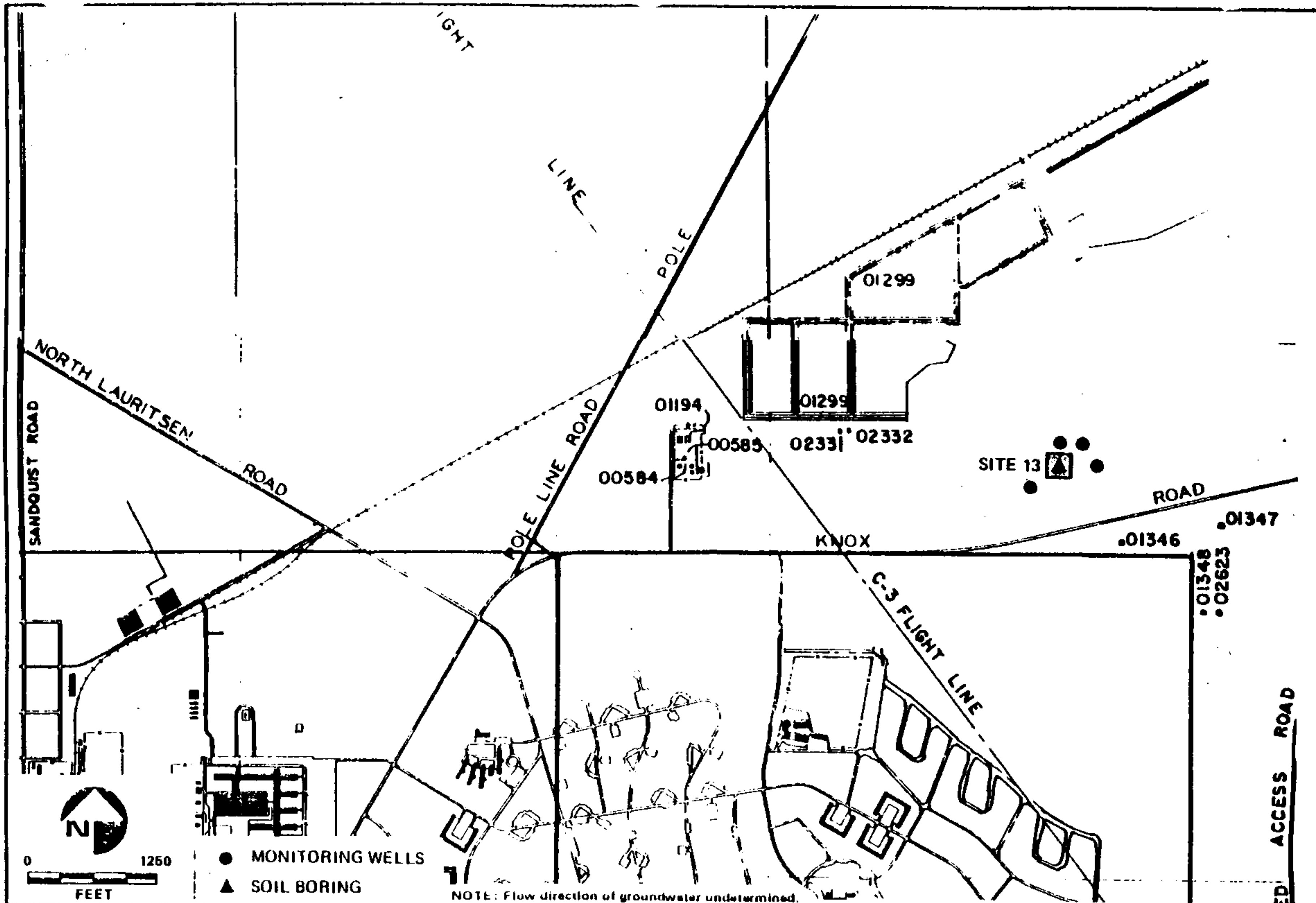
Type of Samples:	Ground water



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 12, SNORT Road Landfill Confirmation Study

FIGURE 3-3



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 13, Oily Waste Disposal Confirmation Study

FIGURE 3-4

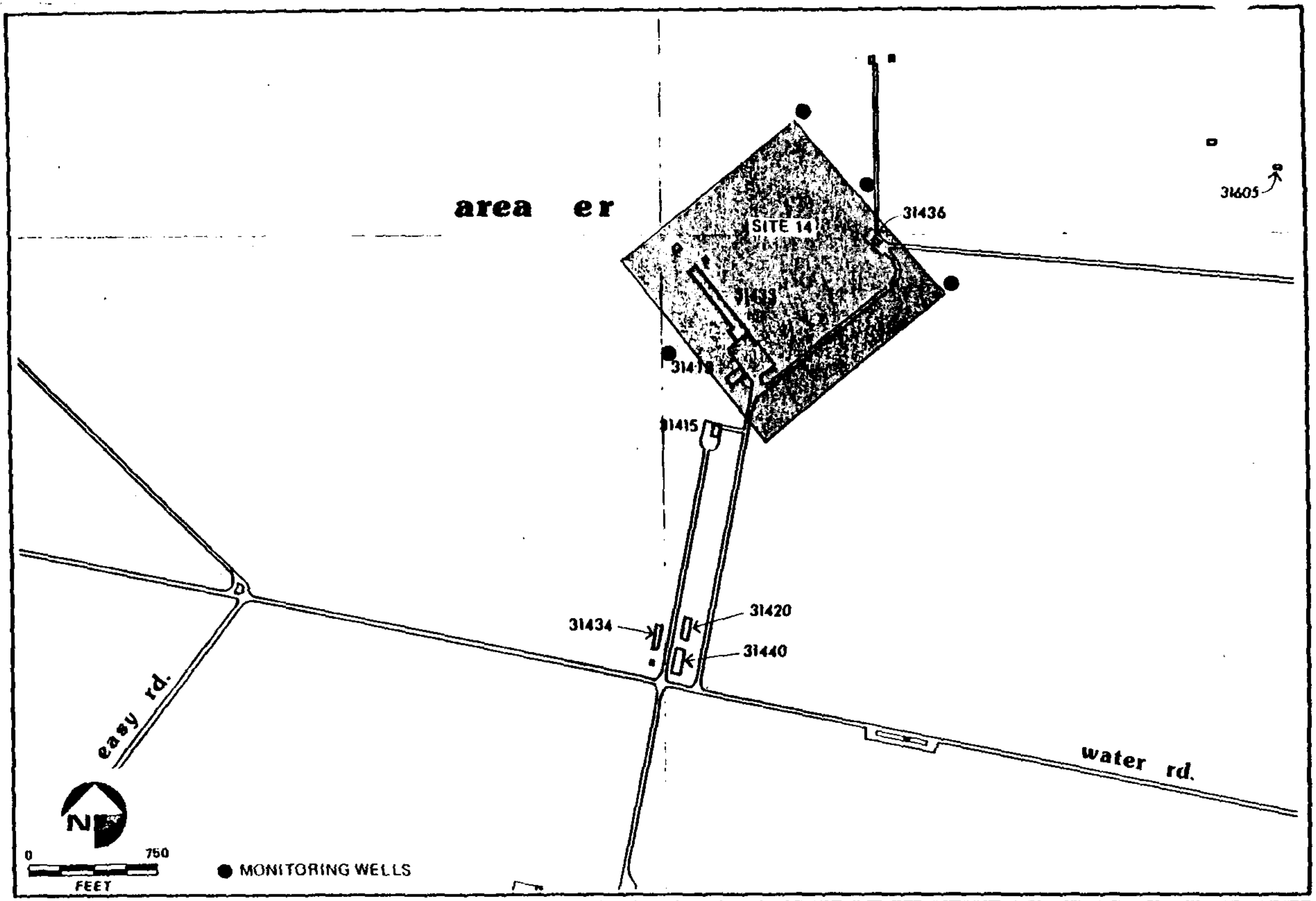
Number of ground water monitoring wells:	Four wells 20 foot deep; 10 feet of casing and 10 feet of screen
Frequency of Sampling:	Water: quarterly for 1 year
Number of Samples:	16 ground water
Testing Parameters:	PIGWQ, IPDWS, EPA 601 and 602, water levels
Remarks:	A total of four wells, three downgradient and one upgradient of the leach fields should be installed. Wells should be screened from 10 to 20 feet. Figure 3-5 shows recommended well locations for Site 14. The exact location of the leach field could not be determined from available data. Therefore, well locations are preliminary until the geometry of the site can be determined and the locations finalized.

3.2.6 <u>Site 15, R Range Leach Field</u>.

Type of Samples:	Ground water
Number of ground water monitoring wells:	4 wells, 20 feet deep; screen 10 feet, casing 10 feet
Frequency of Sampling:	Water: quarterly for 1 year
Number of Samples:	16 ground water
Testing Parameters:	PIGWQ, EPA 601 and 602, water levels
Remarks:	A total of four wells, three downgradient and one upgradient of the leach field should be installed: wells should be screened from about 10 to 20 feet below land surface. Suggested well locations are shown on Figure 3-6. The exact location of the leach field could not be determined from available data. Therefore, well locations are preliminary until the geometry of the site can be determined and the locations finalized.

3.2.7 <u>Site 16, G-1 Range Septic System</u>.

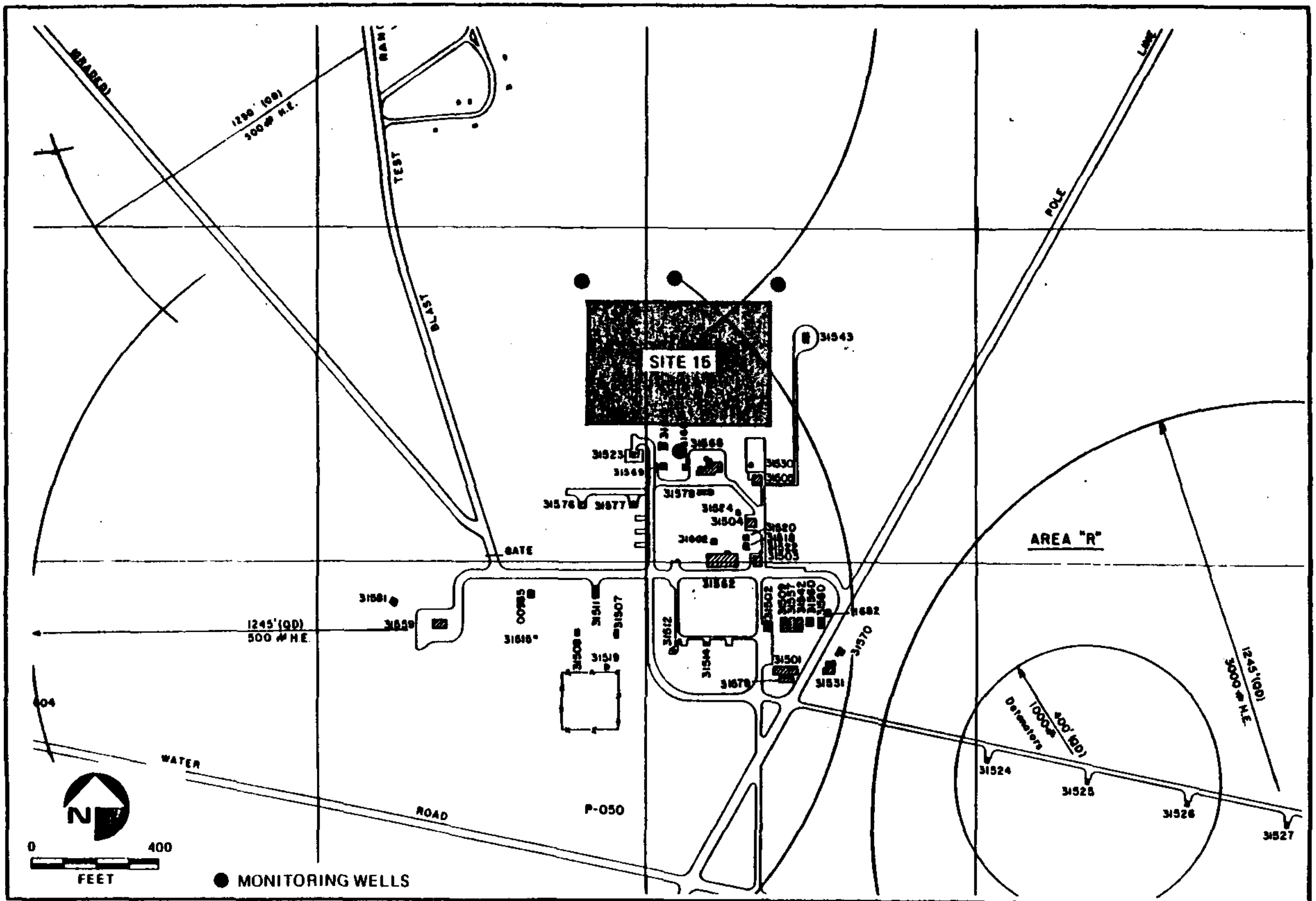
Type of Samples:	Ground water
Number of ground water monitoring wells:	4 wells, 20 feet deep; screen 10 feet casing 10 feet
Frequency of Sampling:	Water: quarterly for 1 year
Number of Samples:	16 ground water



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 14, ER Range Septic System Confirmation Study

FIGURE 3-5



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 15, R Range Septic System Confirmation Study

FIGURE 3-6

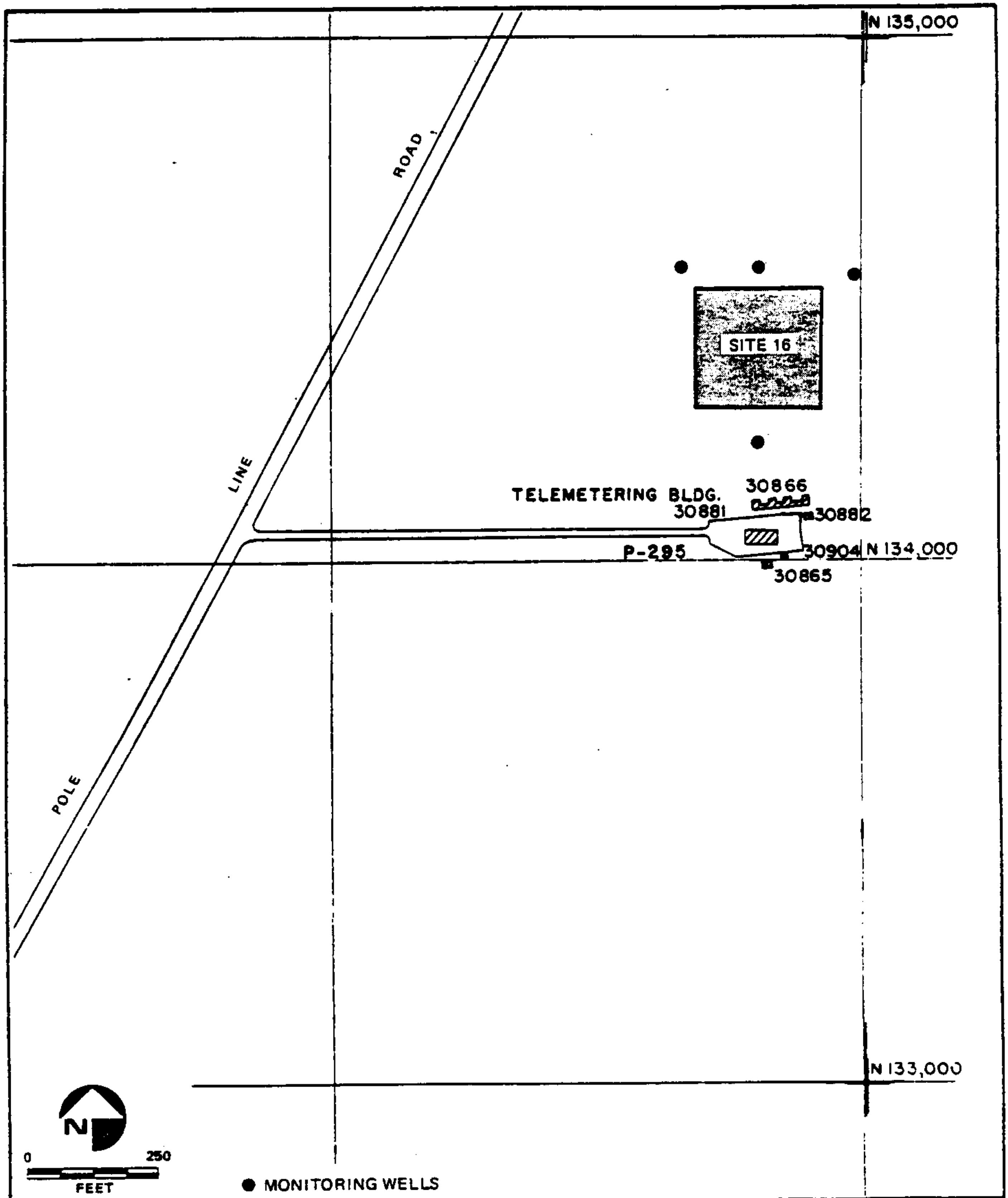
Testing Parameters:	PIGWQ, silver, chromium, water levels
Remarks:	A total of four wells, three downgradient and one upgradient of the leach field should be installed: wells should be screened from about 10 to 20 feet below land surface. Figure 3-7 depicts well sampling locations. The actual boundary of the leach field should be located before final selection is made.

3.2.8 Site 17, G-2 Range Septic System.

Type of Samples:	Ground water
Number of ground water monitoring wells:	4 wells, 20 feet deep; screen 10 feet, casing 10 feet
Frequency of Sampling:	Water: quarterly for 1 year
Number of Samples:	16 ground water
Testing Parameters:	PIGWQ, metals in IPDWS, EPA 601 and 602, water levels
Remarks:	A total of four wells, three downgradient and one upgradient of the leach field should be installed. Wells should be screened from about 10 to 20 feet below land surface. Suggested well sampling locations are shown on Figure 3-8. These are based on incomplete data. Final selection of locations should be made after the boundary of the leach field is better defined.

3.2.9 Site 22, Pilot Plant Road Landfill.

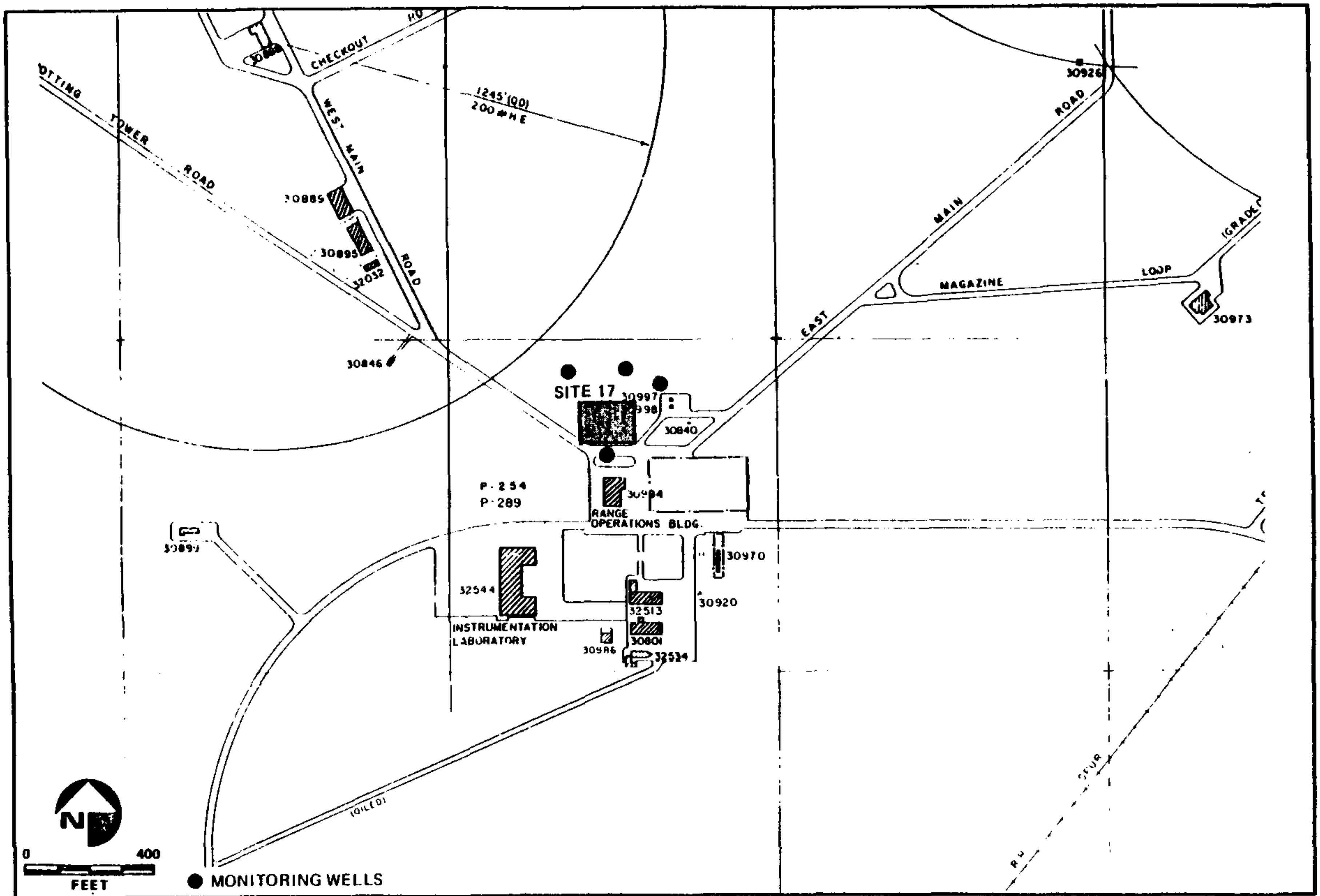
Type of Samples:	Ground water
Number of ground water monitoring wells:	4 wells (total depth 110 feet)
Frequency of Sampling:	Quarterly for 1 year
Number of Samples:	16 samples
Testing Parameters:	PIGWQ, EPA 608, 601, 602, 624, and 625, metals in IPDWS, water levels
Remarks:	This site is on the edge of where the confining layer separates the shallow and main aquifer. It appears that any contaminants leaching from the landfill may enter the main aquifer. If this occurs, the contaminants may migrate with the ground water towards the Ridgecrest well field. The



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 16, G-1 Range Septic System Confirmation Study

FIGURE 3-7



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 17, G-2 Range Septic System Confirmation Study

FIGURE
3-8

depth to water in this area has been estimated to be 90 feet. In this arid environment, this thickness of unsaturated heterogeneous material may adsorb many of the contaminants. However, due to the well field proximity of 3 miles it is recommended that 4 wells be completed for monitoring. Three downgradient and one upgradient well should be sufficient. The screen should be about 20 feet long and be submerged below the water table by 15 feet.

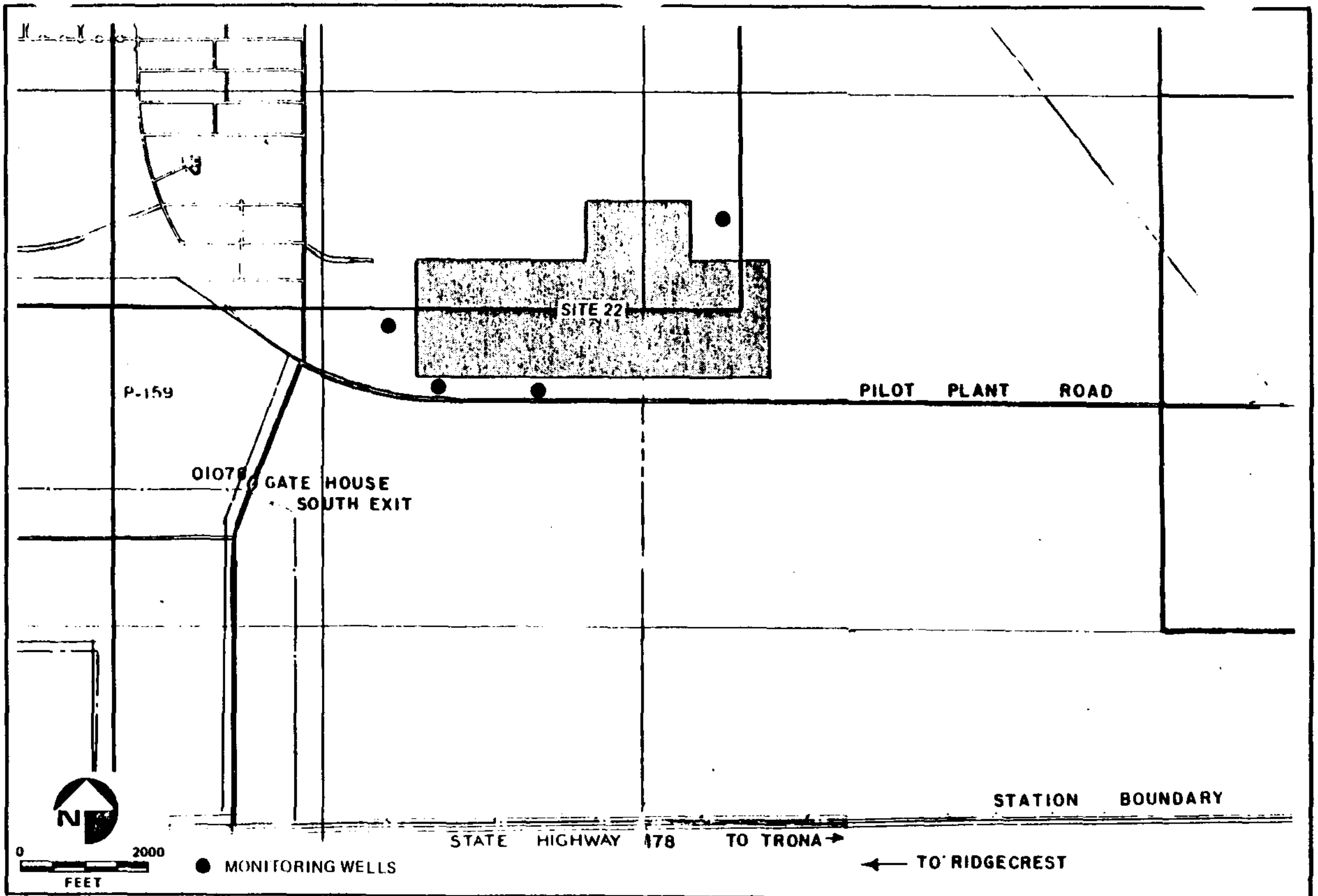
With these wells it may be possible to determine changes in ground water flow and ground water quality. In addition, the local configuration of the water table for this area can be verified. Further characterization studies may still be necessary after well completion. Figure 3-9 provides locations for the suggested monitoring wells.

3.2.10 Site 27, NAF Disposal Area.

Type of Samples:	Ground water
Number of ground water monitoring wells:	4 wells (approximately 35 feet deep; casing to 25 feet and screen from 25 to 35 feet)
Frequency of Sampling:	Quarterly for 1 year
Number of Samples:	16
Testing Parameters:	PIGWQ, metals in IPDWS, EPA 624 and 625, water levels
Remarks:	A total of four wells should be drilled, at the approximate locations shown on Figure 3-10, to verify contamination migration towards a potential receptor, Well 7A, and downgradient. If Well 7A were properly abandoned and sealed the site could be deleted from confirmation because of the lack of a receptor or pathway to threaten human health or the environment.

3.2.11 Site 29, C-1 East Disposal Area.

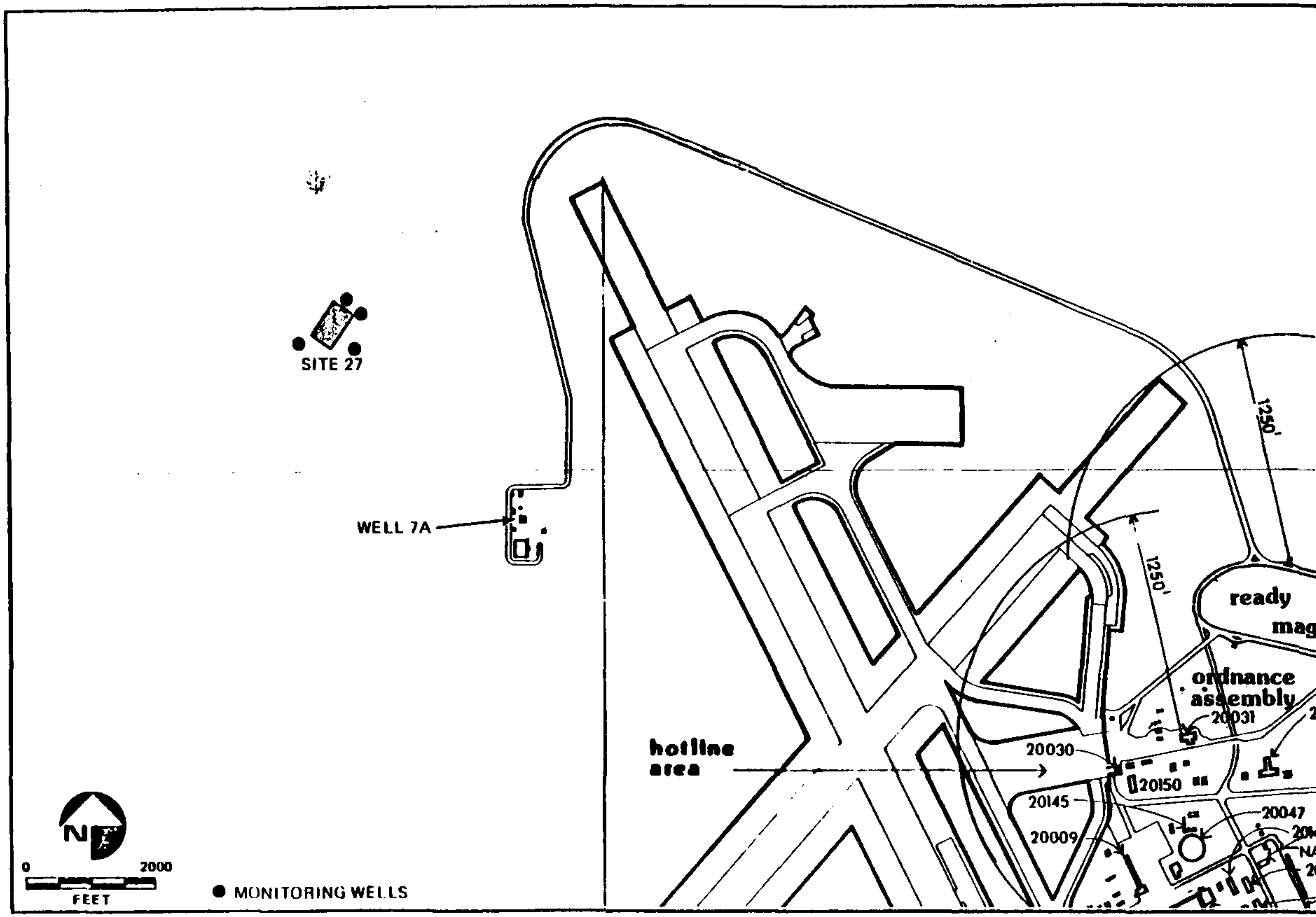
Type of Samples:	Geophysics to clear site from live ordnance; Ground water
Number of ground water monitoring wells:	4 wells; 120 feet deep
Frequency of Sampling:	Quarterly for 1 year



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 22, Pilot Plant Road Landfill Confirmation Study

FIGURE 3-9



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 27, NAF Disposal Area Confirmation Study

FIGURE 3-10

Number of Samples: 16

Testing Parameters: Chlordane, EPA 601, 602, 608, 624 and 625, water levels

Remarks: This site reportedly contains large amounts of 2 percent chlordane (see Chapter 8, 17,000 gallons) and live ordnance. Live ordnance also is reported to surround the site and will make drilling dangerous.

Before drilling any monitoring wells, each drill site will have to be cleared using geophysical techniques. Magnetics and electromagnetics are usual techniques to clear drill sites and these methods will also be useful in defining the boundary of the site by locating the buried cans. After each site is cleared, the drilling program can commence. A total of four wells should be drilled, two between the site and Well 22A (a potential receptor) and two on the opposite side. The wells should be approximately 120 feet below land surface with the screen from 100 to 120 feet. Figure 3-11 shows suggested well locations. An alternate approach would be to properly seal Well 22A and thus eliminate the pathway that could pose a threat to human health.

3.2.12 Site 31, Public Works Pesticide Rinse Area.

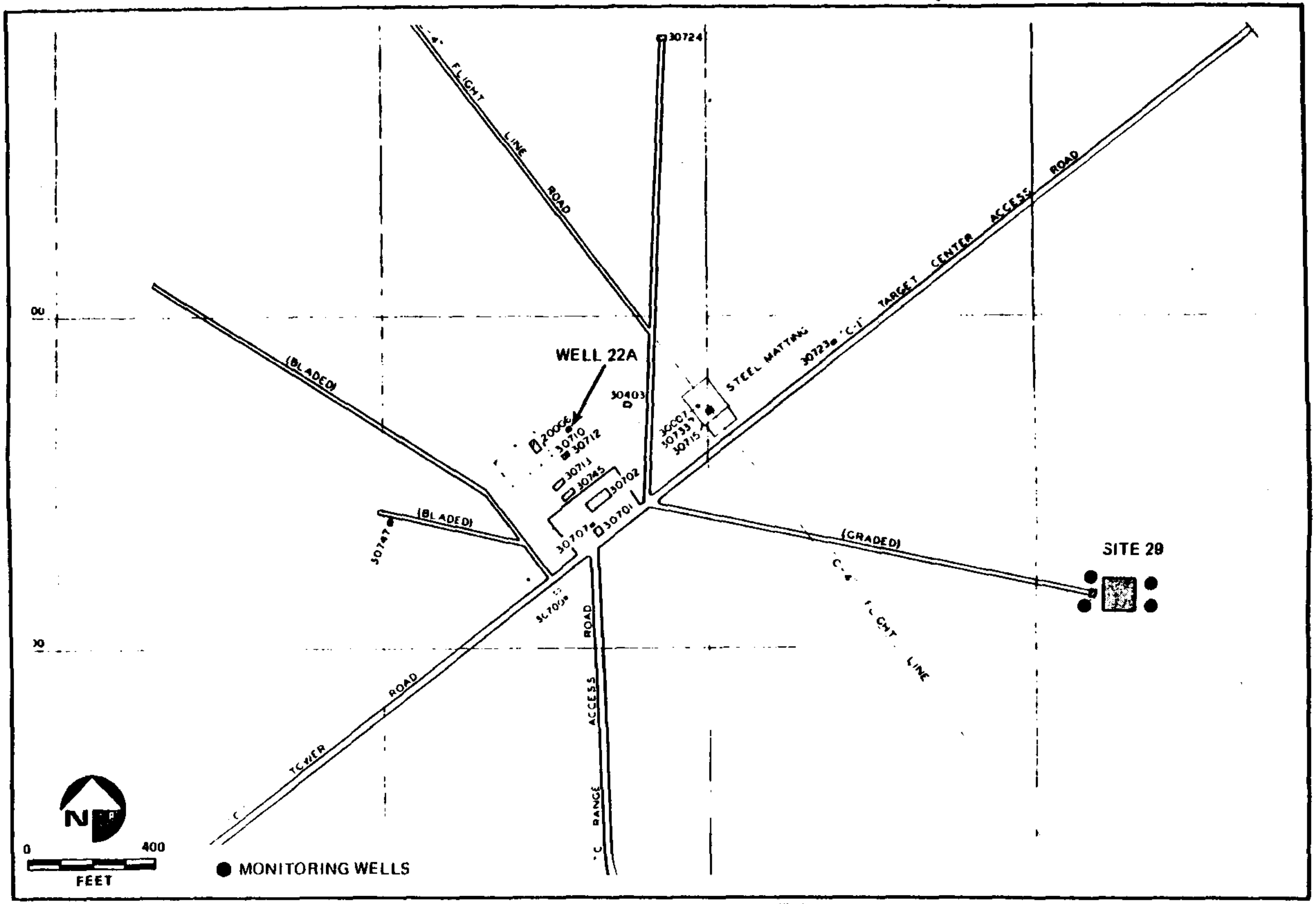
Type of Samples: Soil

Number of soil samples: 10 soil samples

Frequency of Sampling: Soil: once

Testing Parameters: Pesticides (EPA 608)

Remarks: 10 surficial soil samples to a depth of 2 feet should be collected on the spill site. These soil samples will need to be obtained by drilling through the present concrete surface. These should be forwarded to the laboratory for analysis. If pesticides in sufficient concentrations are found, a drilling program should be initiated to determine vertical distribution of pesticides in the unsaturated zone and establish a ground water monitoring program. The criteria levels for determining whether drilling will be necessary vary depending on the pesticides found. Therefore, data on each pesticide analyzed will need to be interpreted separately.



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 29, C-1 East Confirmation Study

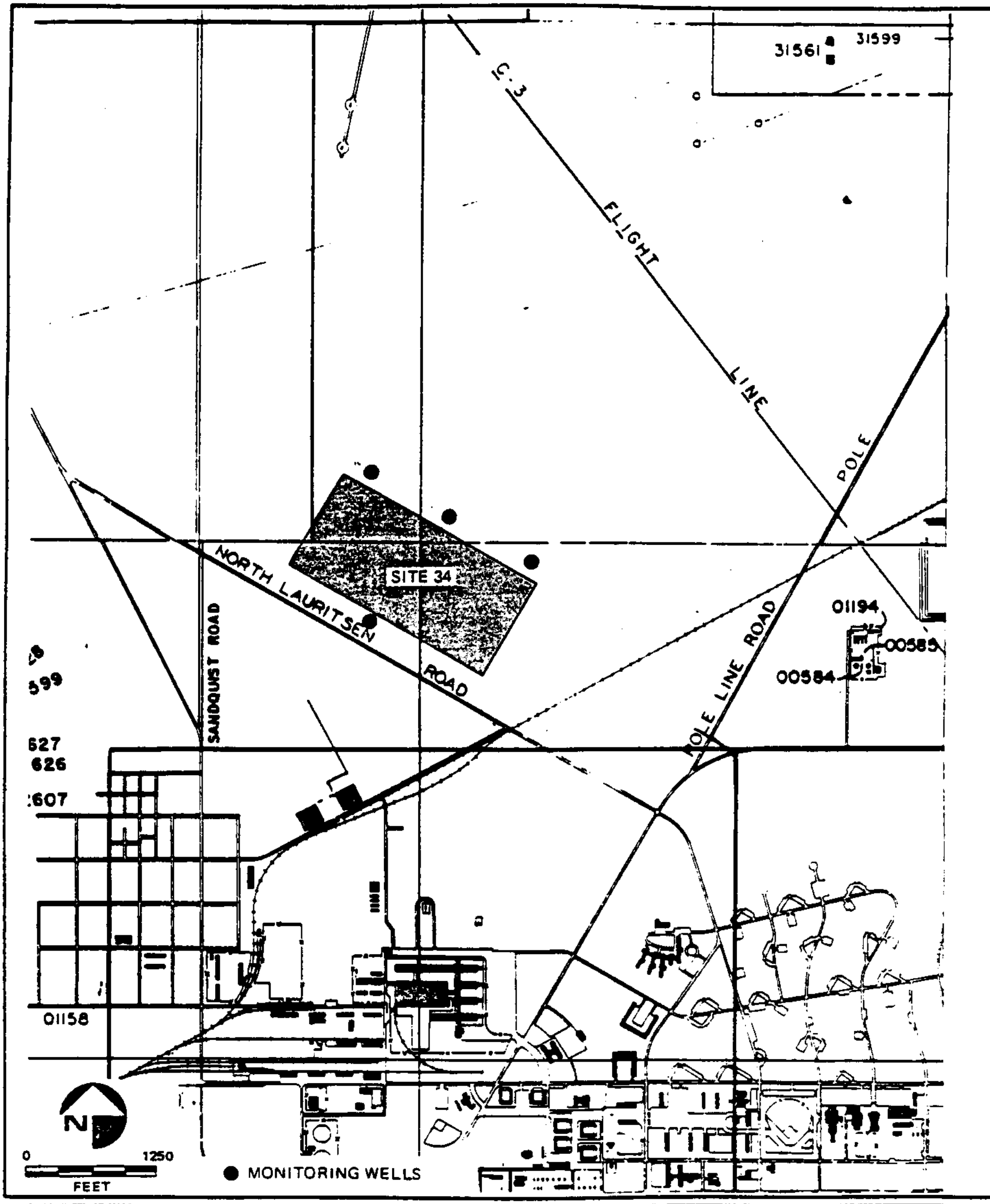
FIGURE 3-11

3.2.13 Site 32, Golf Course Pesticide Rinse Area

Type of Samples:	Ground water Soil
Number of soil samples:	10 soil samples
Frequency of Sampling:	Soil: once
Testing Parameters:	Pesticides (EPA 608)
Remarks:	10 surficial soil samples to a depth of 2 feet should be collected on the spill site. These should be forwarded to the laboratory for analysis. If pesticides in sufficient concentrations are found, a drilling program should be initiated to determine vertical distribution of pesticides in the unsaturated zone and establish a ground water monitoring program. The criteria levels for determining whether drilling will be necessary vary depending on the pesticides found. Therefore, data on each pesticide analyzed will need to be interpreted separately.

3.2.14 Site 34, Lauritsen Road Landfill.

Type of Samples:	Ground water
Number of ground water monitoring wells:	4 wells each 25 feet deep; screen 25-35 feet
Frequency of Sampling:	Quarterly for 1 year
Number of Samples:	16
Testing Parameters:	PIGWQ, EPA 601, 602, 608, 624, 625 and metals in IPDWS, water levels
Remarks:	Four wells, three downgradient and one upgradient of the landfill should be installed with a hollow stem auger. Wells will be 35 feet deep with 10 feet of screen from 25 to 35 feet below land surface. Figure 3-12 shows suggested well locations.



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Site 34, Lauritsen Road Landfill Confirmation Study

FIGURE 3-12

CHAPTER 4. BACKGROUND

4.1 GENERAL BACKGROUND

4.1.1 Location. The Naval Weapons Center (NAVWPNCEN) China Lake administers two major land areas in the Upper Mojave Desert, some 120 air miles northeast of Los Angeles as shown on Figure 1-1. The major land areas are overlaid by restricted air spaces. The isolated desert land combined with restricted airspace overhead provides a physical resource which is vital for support of the Department of Defense and Navy Research, Development, Test and Evaluation (RDT&E) mission for air warfare systems.

The two major NAVWPNCEN land areas are the China Lake Complex, and the Randsburg Wash/Mojave B Complex. The China Lake Complex of 950 square miles contains the majority of the range and test facilities, as well as the NAVWPNCEN headquarters (HQ) and the China Lake Community. The NAVWPNCEN HQ/China Lake Community is located at the south boundary of the China Lake Complex. The Electronic Warfare Threat Environment Simulation (EWTES), located in Randsburg Wash, is the major test facility in the southern complex. The two Mojave B ranges are used as uninstrumented areas for a variety of tests of air-launched ordnance. The Randsburg Wash Access Road, owned by the Navy, connects the two major land areas. Figure 4-1 shows the major land areas in the China Lake area under NAVWPNCEN control.

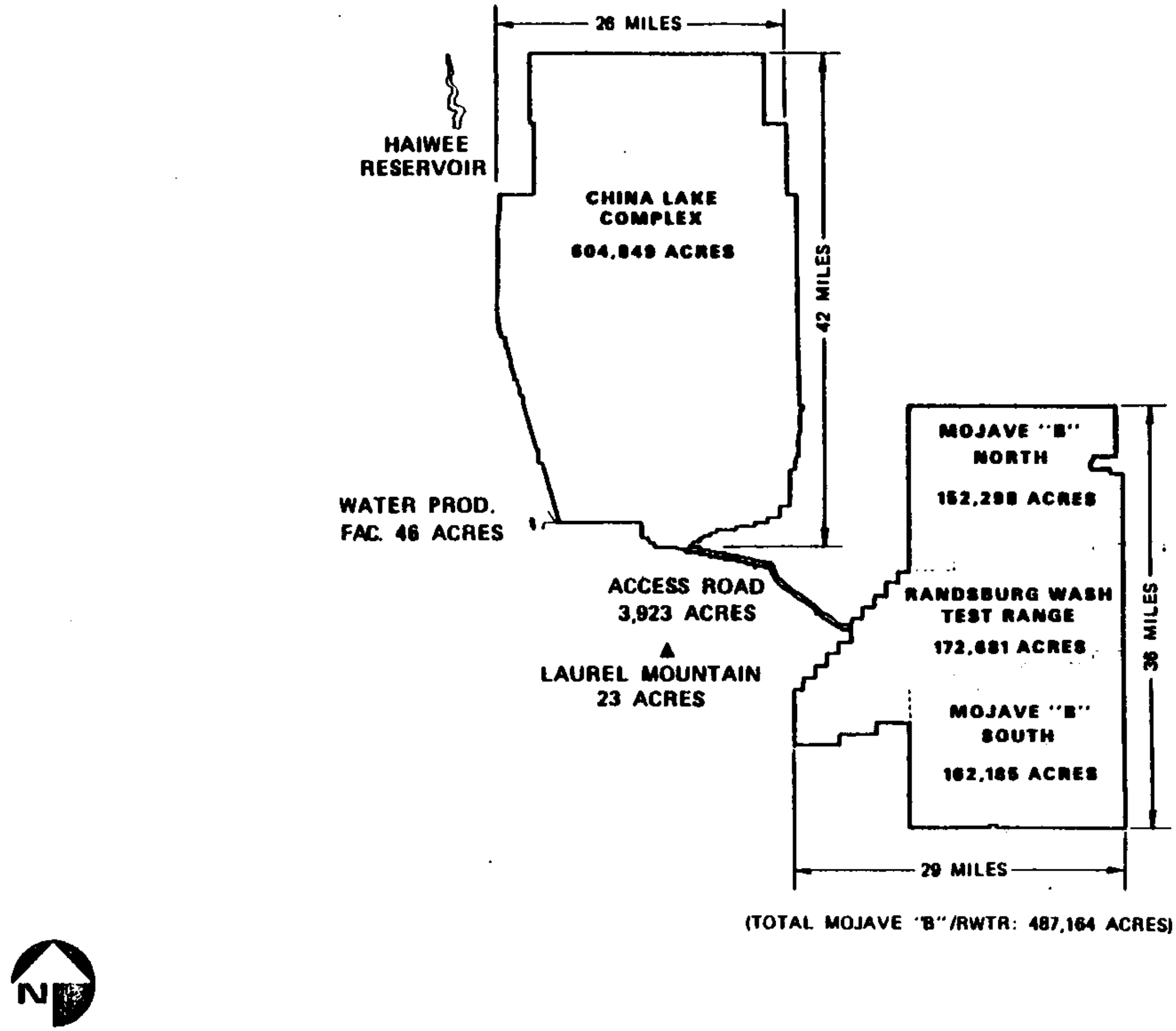
NAVWPNCEN controls a vast area of desert land which includes flat dry lakebeds, washes, and rugged mountains. The varied terrain can support a wide range of test scenarios. The Upper Mojave Desert offers good flying weather and clear visibility for air test operations and collection of test data. The major NAVWPNCEN land areas are surrounded by predominantly undeveloped public lands which provide the buffer zone necessary for test activities.

NAVWPNCEN China Lake is the Navy's largest RDT&E installation, in terms of facilities and land area. Nowhere else does the Navy, or the Department of Defense (DOD), have such extensive laboratories, range facilities, and support facilities located in one place, with the land (one third of the Navy's landholdings in the Continental United States) to provide the operational capability, and the complementary controlled airspace in which to operate.

4.1.2 Adjacent Land Uses. The NAVWPNCEN China Lake Complex lies within three counties: the northern two-thirds of the Complex in Inyo County, and the southern third in Kern County and San Bernardino County. The NAVWPNCEN Randsburg Wash/Mojave B lies in San Bernardino County.

Most of the unincorporated land in the three counties in the vicinity of NAVWPNCEN is Federal land administered by the BLM, and is managed under the California Desert Conservation Area (CDCA) Plan.

Surrounding land uses include the communities of Ridgecrest and Inyokern along the southern boundary of the NAVWPNCEN, the communities of Trona, Argus and West End on State Highway 178 along the southeastern border next to Searles Lake, and



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Major Land Areas Under NWC Control

FIGURE 4-1

the community of Darwin to the north of the NAVWPNCEN boundary off State Highway 190. The small towns of Little Lake and Olancha are located on U.S. Highway 395 which parallels the NAVWPNCEN on the west. The Inyokern Airport is located just west of Inyokern and U.S. 395. Sequoia National Forest is about 12 miles to the west of Inyokern and Death Valley National Monument is only about 1 mile north of the NAVWPNCEN at its closest point. The extensive NAVWPNCEN Mojave B Ranges and the Randsburg Wash test facilities are located about 12 miles southeast of the China Lake Complex. The Fort Irwin Military Reservation adjoins the Mojave "B" Ranges on the east just south of Death Valley National Monument.

4.1.3 History. The Naval Ordnance Test Station (NOTS) was established on 8 November 1943 near China Lake, California, to serve an immediate and a long-range purpose. The immediate function was to support the rocket development work of the California Institute of Technology (Caltech) for the World War II Office of Scientific Research and Development, to test air launched rocket weapons and to furnish primary training in the use of these weapons. The long-range role of the station was to serve as a nucleus from which to evolve a major postware RDT&E center for naval weaponry.

In the summer of 1943, Admiral Ernest King, Commander in Chief of the Fleet, placed a high priority on rocket development, and the Caltech development program was significantly expanded. The early Caltech rocket testing had been done in the canyons at Pasadena and in the Goldstone Range at Camp Haan (now Fort Irwin). Dr. Charles Lauritsen, head of the Caltech research group, began to look for more space for rocket testing. At the same time, Commander Sherman Burroughs Jr., the new head of the Aviation Section, Research Division, of the Navy Bureau of Ordnance, had become convinced of the need for a proving ground for aviation ordnance. A meeting between the two men led to an informal agreement to propose the establishment of a new Navy proving ground on the West Coast, to serve as a center for rocket testing and for the development of aircraft ordnance. Indian Wells Valley, in the northwest corner of California's high desert country, was selected as being the most advantageous of several alternate sites for year-round weapons development and testing operations. Besides an existing airstrip at Inyokern, the site provided a broad expanse of nearly uninhabited desert land, clear skies, and proximity to highways, railroad, power lines, the Los Angeles aqueduct and the southern California industrial area. When the proposal was presented to Rear Admiral William Blandy, he saw an opportunity to prepare the way for a permanent R&D center for naval ordnance. The Navy's priority program for development of the 3.5-inch Caltech aircraft rocket and delivery of the weapons to combat units provided pressure for favorable action on the proposal, leading to the establishment of NOTS. Burroughs, raised to the rank of Captain, was appointed the first commanding officer.

The existing airstrip at Inyokern was used as the temporary base for NOTS test and training operations. The first test was conducted on the new aircraft range (C Range) on December 3, 1943. Also in December, the Aviation Ordnance Development Unit 1 (AODU-1) was ordered permanently assigned to NOTS "as soon as facilities were available," providing the necessary aircraft support. By January, 1944, a master plan for NOTS, site plans, and schematic drawings for the planned buildings were complete. By early 1945, approximately 1000 buildings had been constructed for NOTS at the permanent site near China Lake.

The new facilities included the China Lake Pilot Plant, Armitage Airfield, the Salt Wells Pilot Plant, Michelson Laboratory, and the first technical facility to be built, constructed in a 7-month period in 1944, to provide the new propellant processing plant that was urgently needed for the Caltech rocket program. Within a few years several large test ranges, research laboratories, and small highly specialized production plants were added. Armitage Airfield was completed in May 1945. The Salt Wells Pilot Plant was completed in July 1945 for the Manhattan Project as a production plant for the non-nuclear explosive component of the atomic bomb. The construction of Michelson Laboratory began in 1944; the building was dedicated in May 1948, reaffirming the original concept of NOTS as a permanent center for "research development, and testing of weapons." The China Lake housing was built in a phased construction program as a self-sufficient community for both military and civilian personnel at NOTS. Because only minimal shopping facilities or cultural amenities existed within 100 miles, the China Lake village was developed as a self-sufficient community complete with schools, shopping center, bank, service station, and cultural, religious, and recreational facilities.

At the end of World War II, the Navy took over the Caltech rocket development functions. NOTS assumed technical direction of a broad program of weapon RDT&E activities; the Caltech facilities at Pasadena became the NOTS Pasadena Annex. San Clemente Island was subsequently acquired for tests of underwater launching for the Polaris missile, and antisubmarine rocket (ASROC) tests. In 1967 during reorganization of the Navy laboratories, the Pasadena and San Clemente facilities and the underwater mission functions were separated from NOTS, forming the nucleus of the Navy Undersea Center at Point Loma, San Diego, now part of the Naval Ocean Systems Center (NOSC) San Diego.

The Mojave B Range was established by the Department of the Navy in 1943 as a free aerial gunnery range for the Marine Corps Auxiliary Air Station at Mojave, California. NOTS assumed active administration of the range in 1947. This acquisition expanded NOTS capabilities which had been hampered by joint-use of these facilities with other defense agencies. After the Marine Corps relocated their units from Mojave to Yuma, NOTS acquired control of the Mojave "B" area in 1959. In 1950, the Randsburg Wash Test Range was established by the Department of the Navy to support development and testing of the VT fuze. The Randsburg Wash/Mojave B Complex has been used since then for fuze and large gun testing, as free aerial gunnery ranges for the Navy and Air Force, and most recently for test and evaluation of aircraft tactics and electronic countermeasures equipment in electronic warfare.

The Naval Weapons Center (NAVWPNCEN) was created in 1967, by merging NOTS with the Naval Ordnance Laboratory, Corona, as part of the reorganization of Navy Laboratories. Corona had been responsible for R&D in missile fuzes, guidance systems, countermeasures, and telemetry and development work on the Standard anti-radiation missile (Standard ARM). The Corona functions and the majority of personnel were transferred to China Lake by 1971. The mission of the National Parachute Test Range (NPTR), El Centro and the NPTR personnel were relocated to NAVWPNCEN China Lake in 1979. Two NPTR facilities, the Salton Sea Test Range and the Whirl Tower in Imperial County, were assigned to NAVWPNCEN at that time. The Salton Sea Test Range has subsequently been declared excess to the Center's needs.

4.1.4 Historic Sites. Identified cultural resources within the NAVWPNCEN landholdings include two resources listed in the National Register of Historic Places: Big and Little Petroglyph Canyons and Coso Hot Springs, both located in the China Lake Complex. Big and Little Petroglyph Canyons, were designated a Registered National Historic Landmark in 1964 and included in the National Register. These canyons contain the major site of prehistoric rock drawings of petroglyphs in the Coso Range. Coso Hot Springs was included in the National Register on January 3, 1978. Two sites were included: a site 1 square mile in size at Coso Hot Springs, and a non-contiguous prayer site of undefined size. The basis for the nomination, as stated by the State Historic Preservation Officer, was the cultural value of Coso Hot Springs to the Native Americans, the Native American archaeological values, and the architectural and historical values associated with the commercial resort development.

Two additional potentially significant sites have been identified at the Naval Weapons Center. These are the Coso Mining Village and the Copper City Prehistoric/Historic Resource. The Coso mine camp is located at the 6000-foot elevation on the southeastern flank of the Coso Range in the NAVWPNCEN China Lake Complex. Miners camped at the Coso site in the 1860s, organized the Coso Mining District, and searched for gold, silver and lead. It is believed that a few miners continued to use the Coso Camp and prospect in the mountains through the 1930s depression era. The mine camp of Copper City in Mojave B South includes petroglyph panels, a bedrock mortar and a midden area. While some historic remains also exist at the site, NAVWPNCEN cultural resource management personnel believe that the primary significance of the site will be its prehistoric resources.

4.1.5 Legal Actions. The only legal action involving the NAVWPNCEN relative to waste disposal was taken in March 1984 by the Lahontan Regional Waste Quality Control Board. A clean up and abatement order (No. 84-3) was issued for past discharges to dry wells at Armitage Field.

4.2 MISSION AND FUNCTIONS. The mission and functions of the Naval Weapons Center is defined in the Master Plan update (NAVFAC, 1981) as follows:

The mission of the Naval Weapons Center is to be the principal Navy RDT&E center for air warfare systems (except antisubmarine warfare systems) and missile weapon systems; and the national range/facility for parachute test and evaluation.

The Naval Weapons Center shall establish and maintain, for the Navy and Marine Corps products listed below, the principal in-house support capability, including:

a. A technology base.
b. Technical intelligence assessments.
c. System concept synthesis and analysis.
d. Survivability/vulnerability evaluations.
e. Advanced and engineering development.
f. Manufacturing and design technology development, review and supervision.
g. Test and evaluation.
h. Production support and product assurance.
i. Fleet in-service engineering.

The Naval Weapons Center provides product line support for:

a. Combat System Integration
b. Countermeasures
c. Vehicles
d. Surveillance
e. Weaponry
f. Command Support
g. General Mission Support
h. Special Interest

NAVWPNCEN is a Chief of Naval Material (CNM) laboratory/center. Certain NAVWPNCEN test facilities, known as the Test and Evaluation Facility Base (TEFB), form a designated component of the DOD Major Range and Test Facility Base (MRTFB). NAVWPNCEN is one of nine CNM laboratory/centers. The centers have differing complementary RDT&E missions. The DOD Major Range and Test Facility Base (MRTFB) is comprised of some 25 major T&E field activities, each managed individually by one of the three military services, but all operating under a single uniform DOD funding policy. The NAVWPNCEN test facilities (TEFB) form one of the seven elements of the Navy Test Facility Base (TFB). All Navy TFB components report to, and are responsible to, the Assistant Commander for Test and Evaluation (NAVAIR-06) Naval Air Systems Command.

NAVWPNCEN, as a full-spectrum fleet RDT&E center, maintains professional expertise across the range of technologies applicable to its mission. In support of the Navy's technology base, NAVWPNCEN has attained a recognized reputation in missile propulsion, warheads, fuzing, sensors, and guidance. In addition to established work in electro-optical weapon control technology, NAVWPNCEN has significant capability in electromagnetic weapon guidance technology.

The Center has the research and technical capability and facilities to support all aspects of the acquisition of tactical air weapons and integrated aircraft systems. The Center supports weapons system acquisition during the advanced and engineering development phases, and during production and operational use, in addition to application of its technology base. Assignments vary from full technical and management cognizance to an advisory role to the Program Manager. NAVWPNCEN technical expertise has been successfully applied to Sidewinder, Shrike, Sparrow, HARM, A-7E and F-18 avionics, Harpoon, and many other systems.

A portion of the NAVWPNCEN technology base program is directed toward product improvement. NAVWPNCEN maintains close contact with the Fleet to assess the performance of current hardware, and with higher Navy/DOD sources to ascertain stringent weapons performance requirements.

NAVWPNCEN provides fleet support including fleet introduction of weapon systems, training of prospective ordnance officers, conducting ordnance loadout inspections, and providing senior technical personnel to operational commands through the Navy Science Assistance Program (NSAP). NAVWPNCEN provides operational software support for several highly digitalized major aircraft avionics systems.

The extensive facilities of the NAVWPNCEN TEFB can be used to evaluate a military system completely, from components to full-scale systems. The principal sponsor of work is NAVAIR; however other CNM Systems Commands and CNM laboratory centers utilitze the NAVWPNCEN TEFB. The U.S. Air Force and Army are consistent users of the TEFB (10 percent to 15 percent of the workload) to test aircraft and missiles. Other government agencies and private industry have also used the TEFB to evaluate R&D systems or subsystems. The principal T&E capabilities are:

- component and systems testing of surface and air launched weapons, both captive and firing tests.
- testing of tactical aircraft systems including flight tests of aircraft avionics and defense suppression systems.
- propulsion testing for development of solid, air-breathing, and liquid propulsion units, including static tests of rocket motors.
- ordnance ground testing of weapons systems components and munitions.
- environmental and safety testing of ordnance components and all-up weapons.
- electronic warfare testing for evaluation of electronic countermeasures (ECM) equipment.
- special purpose testing for warhead, fuze, motor, airframe, and other components.
- parachute and escape systems T&E.

Test facilities at NAVWPNCEN provide Developmental Test and Evaluation (DT&E) for the NAVWPNCEN technology and developmental programs, as well as providing DT&E services for other Navy and DOD agencies. NAVWPNCEN supports a separate Navy activity (Squadron VX-5) which provides Operational Test and Evaluation (OTE) services.

4.3 BIOLOGICAL RESOURCES. The following summary of biological resources is taken primarily from Phillips Brandt Reddick (1981) and NAVWPNCEN, Master Plan, (1981).

4.3.1 Vegetation. The vegetation communities of the Naval Weapons Center reflect an environment transitional between the Mojave and the Great Basin Deserts. Previous botanical studies (Zembal et al., 1979; Dedecker, 1980; California Department of Fish and Game, 1980) and Landsat satellite photo interpretations (BLM, 1980a) distinguish six major vegetation types within the NAVWPNCEN.

Each of the six major vegetation types found on the NAVWPNCEN is described below.

4.3.1.1 Forests. The only forest community on the NAVWPNCEN, a pinyon (*Pinus monophyllia*) -juniper (*Juniperus* ssp.) association, occupies less than 1.5 percent of the total NAVWPNCEN land area and occurs only between 7000 and 8000 feet in elevation on Coso and Maturango Peaks (Munz and Keck, 1968). In general, the juniper can tolerate a drier climatic regime and predominates at lower elevations and on southern exposures at higher elevations, whereas pinyon prefers the more mesic high elevation regime and northern exposures at lower elevations. Dominant and subdominant understory species in this community are sagebrush (Artemisia tridentata and A. nova), antelopebrush (Purshia glandulosa), and a variety of annual and perennial grasses.

4.3.1.2 Woodland. An open pinyon-juniper woodland predominates between the elevations of 6500 and 7000 feet on northern portions of the NAVWPNCEN due to the slightly cooler and more moist influences of the Great Basin Desert. Subdominant associates include sagebrush, galleta grass (Hilaria jamesii), squirreltail (Sitanion histrix) and needlegrass (Stipa spp.).

Another high-cover woodland vegetation zone, which is not subject to Great Basin influence, exists between 2000 and 6000 feet in elevation in the northwestern portion of the NAVWPNCEN. The dominante "tree' species in this area is Joshua tree (Yucca brevifolia). Subdominant associates include blackbrush (Coleogyne ramosissima), spiny hopsage (Grayia spinosa), goldenbush (Haplopappus linearifolius), rabbit-brush (Chrysothamnus nauseosus and C. viscidiflorus), needlegrass, squirreltail, and galleta grass, along with an occasional pinyon and/or juniper at the higher elevations.

A low-cover woodland exists between 3000 and 7000 feet in elevation in the northeastern portion of the NAVWPNCEN due to the slightly drier habitat present. Common vegetation components include sagebrush, shadscale (Atriplex confertifolia), needlegrass, galleta grass, squirreltail and cheatgrass (Bromus tectorum).

The southwestern portion of the NAVWPNCEN tends generally to be more arid than the north. The low-cover woodland community occurring between 2000 and 5000 feet in elevation consists of Joshua tree, creosote bush (Larrea tridentata), needlegrass and cheatgrass.

4.3.1.3 Scrub. Scrublands occupy almost 60 percent of NAVWPNCEN lands. Scattered throughout the area between elevations of 2300 and 7000 feet is a high diversity scrub community composed of sagebrush, rabbit-brush, spiny hopsage, winter fat (Eurotia lanata), mormon tea (Ephedra spp.) and grasses. Desert Holly (Atriplex hymenelytra) is a dominant species in a low diversity scrub association which is found in some areas between elevations of 1000 and 5000 feet. The ability to tolerate hot temperatures and dry and possibly gypsiferous soils, enables desert holly to inhabit these dry alkaline washes and slopes.

In the remaining portions of the north, southeast and southwest, two major scrubland associations occur. From playa edges up to 5000 feet in elevation, creosote bush/burro bush (Ambrosia dumosa) associations dominate. Creosote bush grows in characteristically open stands on well-drained slopes, fans and valleys, and predominates especially in the Indian Wells Valley. This moderately diverse community supports understory species such as cheesebush (Hymenoclea salsola), desert senna (Cassia armata) and saltbush (Atriplex spp.).

The second major scrubland association is composed primarily of blackbrush. This vegetation association is characterized by high diversity and is scattered throughout the NAVWPNCEN between elevations of 3800 and 4300 feet. Associated species are shadscale, spiny hopsage, mormon tea, winter fat and scattered Joshua trees.

An ecotonal community occurs in some areas between the blackbrush and creosote bush/burro bush associations (WESTEC, 1979) between elevations of 3800 to 4200 feet. It contains nearly equal elements of both associations and therefore possesses a relatively high species diversity.

4.3.1.4 Scrub/Grassland. Scrub/grassland occurs from playa edges up to about 3200 feet in elevation. This vegetation type is located in only a few scattered places on the NAVWPNCEN, primarily in areas of calcareous, sandy or saline soils. Dominant constituents are four-winged saltbush (Atriplex canescens), needlegrass (Stipa speciosa) and brome (Bromus spp.). Beatley (1975) notes that this community generally does not intergrade with adjacent communities.

4.3.1.5 Scrub/Barren. Scrub/barren vegetation occurs primarily near playas and on the lowest elevations of the NAVWPNCEN, below 3200 feet. This vegetation is tolerant of high temperatures and very low precipitation as well as highly alkaline and saline conditions. The dominant species of this vegetation type is saltbush (Atriplex spp.). Subdominant species include pickleweed (Allenrolfea occidentalis) and inkweed (Suaeda torreyana).

4.3.1.6 Riparian. The riparian areas of the NAVWPNCEN are clustered around the sparsely scattered seeps, springs, wells, and cattle tanks and troughs. Typical dominant plants include willows (Salix spp.), mesquite (Prosopis glandulosa), squaw waterweed (Baccharis sergiloides), and gooseberry (Ribes velutina).

Riparian areas are characterized generally by high species diversity, cover and overall productivity. The wildlife composition of riparian habitats is known to be far more diverse typically than that of adjacent, more xeric habitats (Carothers et al., 1974).

4.3.2 Wildlife. The wildlife assemblage of Mojave Desert habitats in southern California constitutes a very high diversity of animals. At present, over 620 species of amphibians, reptiles, birds and mammals have been recorded within the 25 million-acre California Desert Conservation Area (CDCA) (BLM, 1980a). Many animals found in the Mojave Desert are unique in their specific habitat and requirements and do not occur elsewhere.

4.3.2.1 Mammals. The fewer than 100 mule deer (Odocoileus hemionus) which occur on the NAVWPNCEN are restricted primarily to the pinyon-juniper associations of Coso and Maturango Peaks. Desert bighorn sheep (Ovis canadensis) are rare on NAVWPNCEN lands. Although larger numbers may have existed in the area historically, no bighorn sheep were spotted in 1981 surveys of the Eagle Crags area and the species is now officially listed as extirpated from NAVWPNCEN lands (DeForge, in press). A small herd of bighorn was transplanted to the Eagle Crags Mountains located in Mojave B South in late 1983. Feral horse (Equus caballus) and burro (Equus asinus) are also found on NAVWPNCEN ranges.

Large predators recorded (Ouimette, 1974) on the NAVWPNCEN include mountain lions (Felis concolor) and bobcats (Felis rufus). Other predators and/or opportunists reported (Ouimette, 1974; WESTEC 1979; Zembal et al., 1979) or expected to occur include coyotes (Canis latrans), kit foxes (Vulpes macrotis), gray foxes (Urocyon cinereoargenteus), badgers (Taxidea taxus), ringtail (Bassariscus astutus), striped skunks (Mephitis mephitis), western spotted skunks (Spilogale gracilis), raccoons (Procyon lotor) and Virginia opossums Didelphis virginiana). At least 14 species of bats have been reported from the NAVWPNCEN (Ouimette 1974). Small mammals, rabbits and rodents occupy virtually every habitat within the NAVWPNCEN. Common species include black-tailed jack rabbits (Lepus californicus), desert cottontails (Sylvilagus audubonii), woodrats (Neotoma spp.), deer mice (Peromyscus spp.), pocket mice (Perognathus spp.), and kangaroo rats (Dipodomys spp.).

4.3.2.2 Birds. A general avifauna survey of the China Lake Complex, which includes two saline marshes, is conducted each summer by the NAVWPNCEN Natural Resources Management Office. The Audubon Society also conducts an annual Christmas count at NAVWPNCEN. The number of resident and migratory bird species found on the ranges is extensive and is not detailed here. Many of the species known to occur on the NAVWPNCEN (Ouimette, 1974) are concentrated in riparian areas where food, water, cover and nesting sites are afforded. Between 1979 through 1983, 220 species have been observed on the Naval Weapons Center. Chukars, or Indian red-legged partridges (Alectoris chukar), are an introduced species present on the NAVWPNCEN. Two additional exotic species of game birds, the crested tinamou (Eudromia elegans) and the seesee partridge (Ammoperdix griseogularis), were introduced in 1968 by the California Department of Fish and Game. The current population status of these birds is not known.

4.3.2.3 Reptiles. Lizards of all species common to the high desert can be found on NAVWPNCEN ranges. Species observed include side-blotched lizard (Uta stansburiana), California whiptail (Cnemidophorus tigris mundus), zebra-tailed lizard (Callisaurus draconoides), leopard lizard (Crotaphytus wislizenii), collared lizard (Crotaphytus collaris), desert iguana (Dipsosaurus dorsalis), desert spiny lizard (Sceloporus magister), Panamint alligator lizard (Gerrhonotus panamintinus), desert horned lizard (Phrynosoma platyrhinos), and chuckwalla (Sauromalus obesus). Snake species found at NAVWPNCEN are the rosy boa (Lichanura trivirgata), red racer (Masticophis flagellum piceus), common kingsnake (Lampropeltis getulus), long-nosed snake (Rhinocheilus lecontei), gopher snake (Pituophis melanoleucus), glossy snake (Arizona elegans), western shovel-nosed snake (Chionactis occipitalis), and Mohave rattlesnake (Crotalus scutulatus). The desert tortoise (Gopherus agassizi) is present in limited distribution at NAVWPNCEN, particularly, in the southern range areas.

4.3.2.4 Amphibians. Amphibians reported by Ouimette (1974) to occur on the NAVWPNCEN include the western toad (Bufo boreas), red-spotted toad (Bufo punctatus), Pacific treefrog (Hyla regilla), leopard frog (Rana pipiens), western spadefoot toad (Scaphiopus hammondii) and tiger salamander (Ambystoma tigrinum). The paucity of amphibian species reflects the scarcity of water sources on the NAVWPNCEN.

4.3.2.5 Fish and Invertebrates. The three fish species reported on the NAVWPNCEN are the Mohave chub (Gila bicolor mohavensis), the mosquito fish (Gambusia affinis) and the introduced goldfish (Cassia sp.). Four hundred Mohave chubs were introduced into Lark Seep in 1970 and have prospered since that time. Goldfish inhabit the channels on the Center lands. The present population status of these species is unknown. Little information is available concerning the aquatic invertebrate population of the NAVWPNCEN.

4.3.3 Sensitive Species.

4.3.3.1 Plants. The term sensitive is employed herein to signify rare, endangered, threatened, endemic or otherwise restricted species. Those sensitive plants known to exist or to have potential habitat on the NAVWPNCEN are shown on Table 4-1. Although no comprehensive studies of sensitive plant species have been conducted on the NAVWPNCEN, 22 species of plants known to occur in the NAVWPNCEN region are listed by the California Native Plant Society as rare or endangered (CNPS, 1980). Some of these species, while as yet not recorded from the NAVWPNCEN, are anticipated to occur there. The U.S. Fish and Wildlife Service is considering federal designation for two of these species, Eriophyllum mojavense and Chorizanthe spinosa, as endangered (USFWS, 1983a). Also under consideration for federal listing as threatened is Sclerocactus polyancistrus (USFWS, 1983a). Various other species are known to be regionally endemic.

4.3.3.2 Wildlife. Sensitive wildlife is used herein to refer to species designated as rare, threatened or endangered by the U.S. Fish and Wildlife Service, the California Department of Fish and Game, the Bureau of Land Management, or other knowledgeable agencies or organizations.

Twenty-four sensitive animal species are listed for the NAVWPNCEN area including 5 species of mammals, 16 birds, two reptiles and one amphibian. Ten of the 24 species are designated on state and federal rare, threatened and endangered species lists. The list of sensitive wildlife species is shown on Table 4-2. Of concern for the issues addressed in this IAS is the Mohave chub. This species (Gila bicolor mohavensis) is listed as endangered by the U.S. Fish and Wildlife Service (USFWS, 1983b) and the California Department of Fish and Game (CDFG, 1980). The Mohave chub was introduced into Lark Seep in 1970 as a conservation measure by the CDFG and now is present in the G-1 Seep as well as the channel connecting the two marshy areas. The location is shown in Figure 4-2. This species is of interest because its habitat borders a major ground water discharge area toward which hazardous wastes may migrate.

The Inyo brown towhee (Pipilo fuscus eremophilus) is well documented in the China Lake Complex, primarily at shrubby thickets near springs in the rugged canyons. This bird is listed as endangered by the CDFG (1980), but has no federal listing at this time. The least Bell's vireo is found in riparian habitat in Mountain Springs Canyon (WESTEC Services, 1982). A sensitive mammal species, the Mojave ground squirrel (Spermophilus mohavensis) has been observed in the China Lake Complex. In the spring of 1978, its presence was confirmed near Coso Hot Springs. The Mojave ground squirrel is listed as rare by the CDFG (1980), but is not listed by the USFWS. Although listed as rare by the state, this small ground squirrel is commonly found in the area from Kramer's Corner north to the Indian Wells Valley, and can be seen also in Rose Valley and in the Coso Basin, according to NAVWPNCEN Natural Resources Management personnel (NAVWPNCEN, 1981). The desert tortoise (Gopherus agassizi) has been proposed for designation as threatened by the USFWS (Berry and Nicholson, 1979). It is observed occasionally in the Mojave "B" Complex and only rarely in the China Lake Range area (Kohfield, 1980).

Table 4-1. Sensitive Plant Species of the Naval Weapons Environs

1. *Phacelia mustellina* [1,2]
   Death Valley round-leaved phacelia

2. *Arctomecon merriamii* [1]
   White bear-poppy

3. *Astragalus lentiginosus* var. *borreganus* [1]
   Borrego milk-vetch

4. *Galium hypotrichium* var. *tomentellum* [1]
   Telescope Peak bedstraw

5. *Gilia ripleyi* [1]
   Ripley's gilia

6. *Juncus nodosus* [1]
   Knotted rush

7. *Pholisma arenarium* [1, 4, 5]
   Pholisma

8. *Dudleya saxosa* ssp. saxosa [1, 3]
   Panamint live-forever

9. *Sclerocactus polyancistrus* [2]
   Mohave bisnaga

10. *Hemizonia arida* [1]
    Red Rock tarweed

11. *Petalonyx thurberi* ssp. *gilmanii* [1]
    Death Valley sandpaper plant

Table 4-1. Sensitive Plant Species of the Naval Weapons Environs (Continued)

12. Dalea arborescens var. arborescens [1, 2]
Mohave indigo bush

13. Chorizanthe spinosa [1, 2,]
Mohave chorizanthe

14. Cymopterus deserticola [1]
Desert cymopterus

15. Eriogonum eremicola [1]
Wild Rose Canyon buckwheat

16. Eriogonum microthecum var. panamintense [1]
Panamint Mountains buckwheat

17. Sidalcea covillei [1]
Owens Valley Checkermallow

18. Spartina gracilis [5]
Alkali cordgrass

19. Canbya candida [5]
White canbya

20. Viguiera reticulata [3, 5, 6]
Leather-leaved viguiera

21. Euphorbia ocellata var. kerbyi [5]

22. Cymopterus ripleyi var. barnebyi [5]

Table 4-1. Sensitive Plant Species of the Naval Weapons Environs (Continued)

23. _Astragalus jaegerianus_ [1]
Lane Mountain milk-vetch

24. _Astragalus lentiginosus_ var. _micans_ [1]
Shining milk-vetch

25. _Centaurium nemophilum_ [1]
Spring-loving centaury

26. _Eriophyllum mohavense_ [1, 2]
Barstow eriophyllum

27. _Gilmania luteola_ [1]
Golden carpet

28. _Cymopterus gilmanii_ [1]
Gilman's cymopterus

29. _Antirrhinum filipes_ [3, 6,]
Twining snapdragon

30. _Phragmites communis_ var. _beslandi_ [4, 6]
Carizzo grass

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[1]Smith et al., (1980)
[2]Ayensu and DeFilips (1978)
[3]Zembal et al., (1979)
[4]Twisselman (1967)
[5]Henrickson (1980)
[6]Regionally endemic

Table 4-2. Sensitive Wildlife Species known to Occur on or in the Vicinity of the Naval Weapons Center

Species	Federal endangered	State threatened	State rare	State endangered	State bird spp. of special concern--highest priority	State bird spp. of special concern--second priority	Bureau of Land Management--sensitive	National Audubon Soc. Blue list--1982	Regionally endemic	Known habitat on NWC	Potential habitat on NWC	Native to NWC	Introduced to NWC
Desert bighorn (Ovis canadensis nelsoni)[1]							X			X		X	
Mohave ground squirrel (Spermophilus mohavensis)[2,3]			X						X		X		
Yellow-eared pocket mouse							X			X		X	
(Perognathus xanthonotus)[1]							X			X		X	
Panamint kangaroo rat (Dipodomys panamintinus)[1]							X			X		X	
Southern grasshopper mouse (Onychomys torridus clarus)[2]								X	X		X		
Inyo brown towhee (Pipilofuscus eremophilus)[1,3]				X					X		X		
Osprey (Pandion haliaetus)[1]							X			X			
Golden eagle (Aquila chrysaetos)[1]							X			X		X	
Bald eagle (Halaetus leucocephalus)[3]	X			X					X		X		
Prairie falcon (Falco mexicanus)[1,5,8]							X		X		X		X
Marsh hawk (Circus cyaneus)[3,5,7,8]					X		X		X		X		
Burrowing owl (Athene cunicularia)[3,5,7,8]					X		X		X		X		
American kestrel (Falco sparverius)[5]							X		X		X		
Loggerhead shrike (Lanius ludovicianus)[5,8]							X		X		X		
Yellow warbler (Dendroica petechia)[3,7]						X				X		X	
American peregrine falcon (Falco columbarius)[3]	X			X	X					X			
White pelican (Pelecanus erythrorhynchos)[3]					X					X			
White-faced ibis (Plegadus chihi)[3]					X					X			

Table 4-2. Sensitive Wildlife Species known to Occur on or in the Vicinity of the Naval Weapons Center (Continued)

Species	Federal endangered	State threatened	State rare	State endangered	State bird spp. of special concern--highest priority	State bird spp. of special concern--second priority	Bureau of Land Management--sensitive	National Audubon Soc. Blue list--1982	Regionally endemic	Known habitat on NWC	Potential habitat on NWC	Native to NWC	Introduced to NWC
Common flicker (*Colaptes cafer*) [3]					X					X			
Snowy plover (*Charadrius alexandrinus*) [3]						X				X			
Least Bell's vireo (*Vireo pusillus bellii*) [6,7,8]				X	X		X	X				X	
Desert tortoise (*Gopherus agassizi*) [2]	X						X			X			
Mohave chub (*Gila bicolor mohavensis*) [3, 4]	X			X						X			X
Tehachapi slender salamander (*Batrachoseps stebbinsi*) [2]			X								X		

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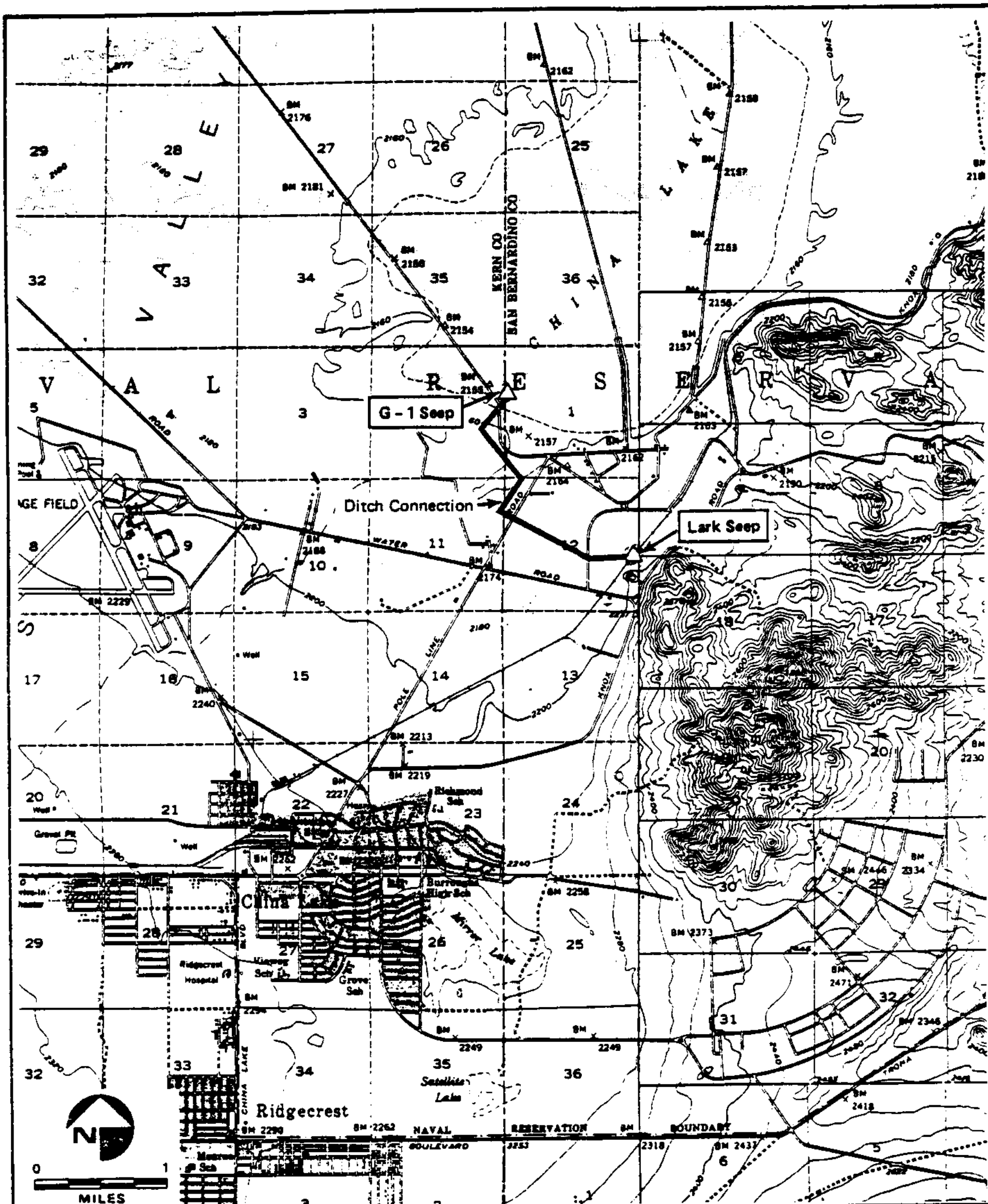
[1]BLM (1980a)
[2]Zembal et al. (1979)
[3]California Department of Fish and Game (1980)
[4]Ouimette (1974)
[5]WESTEC Services (1979)
[6]WESTEC Services (1982)
[7]Remsen (1978)
[8]Tate and Tate (1982)



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Location of Habitat for the endangered Mohave Chub (G - 1 and Lark Seeps)

FIGURE 4-2

4.4 PHYSICAL FEATURES.

4.4.1 Climate. The climate surrounding the area of the NAVWPNCEN is arid with the average precipitation amounting to 3 to 4 inches a year in the valleys. Most of this precipitation falls as rain during the period October-March with December being the wettest month. Precipitation increases to about 10 inches in the Argus Mountains and to 10 inches or more per year along the crest of the Sierra Nevada.

The summers of Indian Wells Valley are characterized by hot days and cool evenings and nights. Warm days and cold nights are customary during the winters.

Wind velocities are high throughout the Indian Wells Valley with the prevailing winds coming from the southeast. Wind velocities in excess of 25 mph have been recorded for all months of the year, and wind velocities in excess of 50 mph have been recorded for the period between October through June.

4.4.2 Topography. Indian Wells Valley is virtually a closed basin bounded on the west by the steep escarpment of the southern Sierra Nevada, on the east by the Argus Range, and on the south by the El Paso Mountains. On the north the Valley is separated from the Coso basin by a low ridge and a lower narrow divide, and from Rose Valley by the Coso Range. Low ridges on the southeast of Indian Wells Valley separate it from Salt Wells Valley.

Broad alluvial fans extend from the mounts of Sierra Nevada canyons, forming bajadas several miles in width. These bajadas slope from the escarpment eastward to the east-central part of the valley which is occupied by low playas; the largest and topographically lowest of these playas being China Lake. Along the western edge of the playa area small sand dunes are common. The transition zone between the toes of the fans and the large east-central playas, contains sand deposits with small hollows, in which playa deposits are found. At the north end of the valley the alluvial cover is thin. In fact, there is almost no alluvial deposits covering the gently southward sloping basalt flows and older lacustrine deposits.

A low ridge underlies Ridgecrest and much of the residential section of the Naval Weapons Center. Alluvial fans and bajadas slope gently northward from the Rademacher Hills and the El Paso Mountains which are located south of the NAVWPNCEN. Salt Wells Valley lies southeast of NAVWPNCEN and Indian Wells Valley and is topographically lower than Indian Wells Valley.

Coso Basin is a topographic depression whose lowest part is occupied by a dry lake. The basin is bounded by the Coso Range on the north, by the Argus Range on the east, by basalt and older lacustrine deposits on the south and southwest, and by extensive alluvial fans of the Argus Range on the southeast.

Rose Valley is nearly isolated from Indian Wells Valley and is an extension of the Owens Valley structural trough. The valley is bounded on the west by the escarpment of the Sierra Nevada, and on the east by the Coso Range. Volcanic flows bound Rose Valley on the southeast. Rose Valley is tributary to Indian Wells Valley through surface runoff and underflow from Little Lake.

4.4.3 Geology.

4.4.3.1 Regional Geology. Indian Wells Valley and parts of Rose Valley, Coso Basin and Salt Wells Valley comprise a single down-faulted block bounded by major fault zones. This down-faulted block is bounded by the Sierra Nevada fault zone on the west, the Argus fault zone on the east, the Garlock fault zone on the south and probably the Wilson Canyon fault zone on the northeast.

The oldest rocks in the area are those of the basement complex. These rocks are considered to range in age from Paleozoic to late Mesozoic. The rocks of the basement complex surround the main valley area and also form the structural basin which is filled with deposits of Tertiary and Quaternary age. The basement complex is comprised of igneous and metamorphic rocks.

Within this area, Tertiary continental deposits overlie the basement complex with angular uniformity. These continental deposits include indurated fluviatile and lacustrine sediments and extrusive and intrusive volcanic rocks that range in age from Paleocene to Pliocene. The extent of these deposits northward beneath the central part of the valley is unknown. Outcrops of these continental deposits occur on the northeast side of the El Paso Mountains.

The continental deposits are overlain uncomformably by residual cappings and agglomerates derived from the Black Mountain Basalt. This formation consists of extrusive and intrusive olivine basalt flows ranging from late Pliocene to Pleistocene time.

Older alluvium deposists which generally unconformably overlie the basement complex or the continental deposits, consist of undeformed to moderately deformed deposits of silt, sand, gravel, and boulders. These deposits are over 800 feet thick and are considered to be middle Pleistocene in age, but the lowermost part may be late Tertiary in age. Interbedded with and in part overlying these older alluvium deposits are lacustrine deposits.

At the northern end of Indian Wells Valley and north of Coso Basin, unnamed volcanic rocks comprise a group of mostly basalt flows several hundred feet thick. These volcanic rocks are interbedded with the younger alluvium.

The younger alluvium consists principally of beds of unconsolidated clay, silt, sand and gravel derived largely from the Sierra Nevada, and also, to a lesser degree from the other mountains surrounding the central Valley area. The younger alluvium is considered at depth to be middle to late Pleistocene in age, and at the surface to be Holocene in age.

Fan deposits are correlative with the younger alluvium and are comprised of unconsolidated clay, silt, sand, gravel, and boulders in a heterogenous mixture. The surface slope of these deposits exceeds 200 feet per mile in the study area. Younger lacustrine deposits include beds of silt and silty clay and are associated with the late Pleistocene Lake Searles and Lake China.

Playa deposits of gray silt, yellow, green, and blue plastic clays, and occasional sand lenses occur in the dry lake areas of Indian Wells and Salt Wells Valleys. The age of the uppermost playa deposits are Holocene.

The youngest deposit in Indian Wells Valley is wind-blown sand which forms sand dunes with interdune playa deposits. This deposit occurs on all other formations and can be observed to form on a windy day.

The regional surficial geologic map is shown on Figure 4-3. The subsurface geology for the area is described by the cross sections located on the map and shown in Figure 4-4.

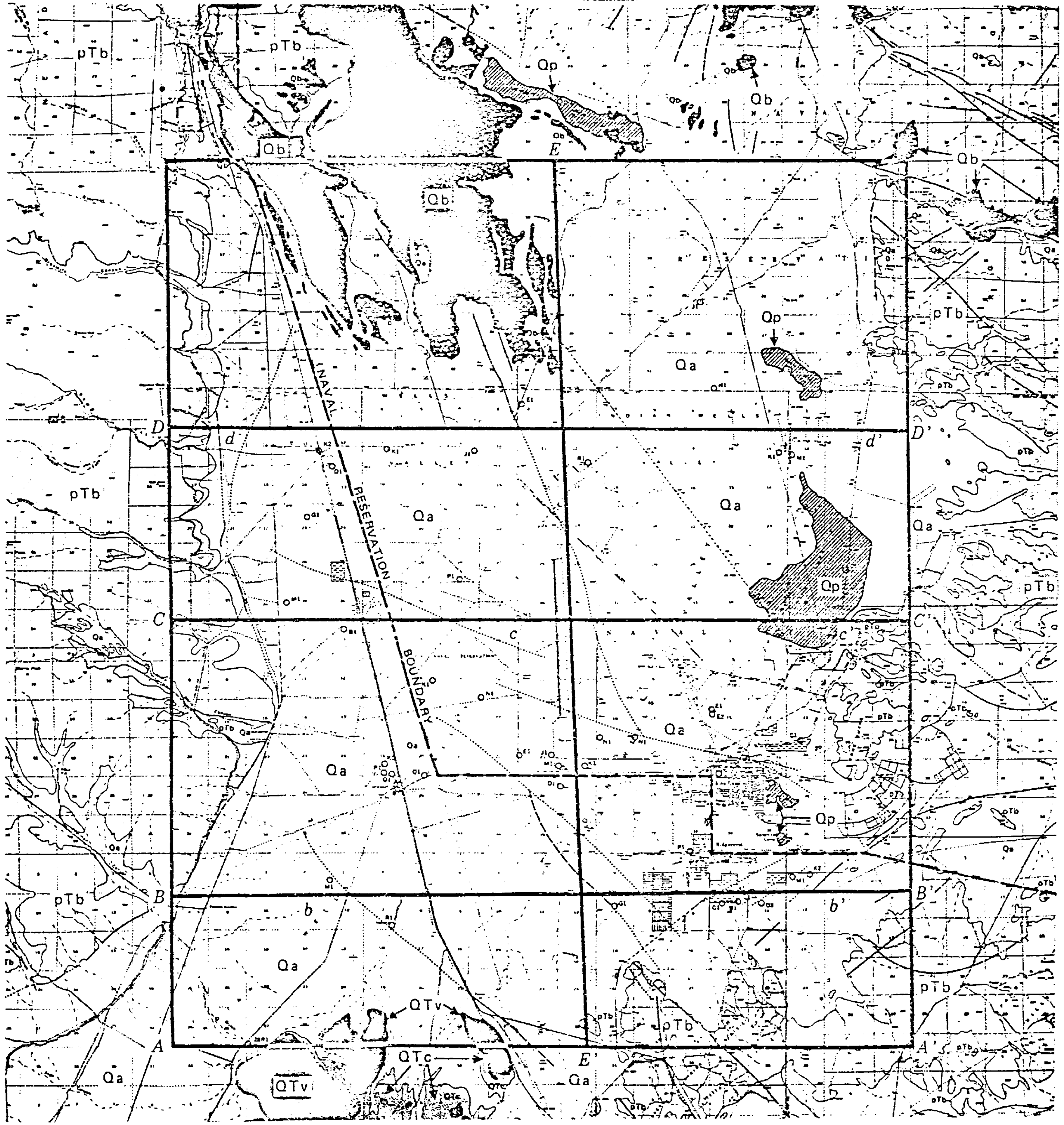
Much of the unconsolidated material was deposited during the Pliocene and Pleistocene epochs. Severe climatic changes during the Pleistocene resulted in huge ice masses covering much of the Sierra Nevada. As climate later warmed, the glaciers melted, furnishing runoff which filled the Owen Lake (a glacial Pleistocene lake) and overflowed into Indian Wells Valley, forming China Lake. According to the literature, drainage from China Lake flowed through a gorge southeast of the present China Lake playa into Salt Wells Valley, hence into Searles Lake. Searles Lake at one time rose to the height of China Lake, forming one large lake of 380 square miles in area. It is believed that the maximum depth of China Lake was not more than 100 feet (Zbur, 1963). The gorge which drained China Lake is now partially filled with windblown sand and is about 40 feet higher than the present China Lake playa.

4.4.3.2 Geologic Structure. As mentioned, Indian Wells Valley and parts of Rose Valley, Coso Basin, and Salt Wells Valley comprise a single down-faulted block formed by three and possibly four major fault zones. These major fault zones are the Sierra Nevada on the west, the Argus on the east, the Garlock on the south, and probably the Wilson Canyon on the northeast. Locally, complex faulting occurs in all the bordering ranges, but these faults, though influencing the regional structure of the area, have not determined the basic structure of the above mentioned valleys.

The Sierra Nevada fault zone lies along the west side of Indian Wells Valley and along the east side of the Sierra Nevada. The vertical movement on this fault zone has uplifted the Sierra Nevada and downdropped the Indian Wells Valley (Kunkel and Chase, 1969). The trace of this zone, though largely concealed beneath alluvial fans, extends northward beyond Indian Wells Valley (Kunkel and Chase, 1969).

The Argus fault zone lies along the west side of the Argus Range. The vertical movement on this fault zone has uplifted the Argus Range and downdropped Indian Wells Valley. According to Kunkel and Chase (1969), the north end of the fault zone seems to be terminated or offset by the Wilson Canyon fault zone. The Argus fault probably extends north between the Coso and Argus Ranges. The southern extent of the Argus fault zone is not known, but the zone seems to split—one fault exposed at the divide between Indian Wells and Salt Wells Valley extends to the southeast and is concealed beneath the alluvium of Salt Wells Valley and the other seems to trend southerly across the outcrop of older lacustrine deposits. The trace of this fault in the El Paso Mountains to the south cannot be determined. Considerable faulting occurs along the north side of the El Paso Mountains, a part of which may be related to the Argus fault zone and part of which may be related to the Garlock fault zone (Kunkel and Chase, 1969).

The Garlock fault zone on the south flank of the El Paso Mountains marks the southern margin of the area considered. This fault zone branches from the San



EXPLANATION

WATER-BEARING STRATIGRAPHIC UNITS

Holocene

Qp

Playa deposits

Unconsolidated silt and clay beneath small lakebeds; yield small quantities of water to wells, generally of poor quality

Pleistocene and Holocene

Qa

Alluvium

Unconsolidated, moderately to well-sorted gravel, sand, silt, and clay; carried moderate distance from source area; yields large quantities of water to wells

Paleocene to Pleistocene(?)

QTc

Continental deposits

Include the Coso, Ricardo, and Goler Formations
The Coso Formation consists of steeply dipping beds of white pumice, composed of particles from one-eighth to several inches in diameter, and some silt, sand and gravel; locally above the regional water table. Age: late Pliocene or early Pleistocene
The Ricardo Formation consists of moderately to highly compacted siltstone, sandstone, limestone, clay, shale, opal chert, conglomerate, tuff; yields little water to wells, generally of poor quality. Age: Pliocene
The Goler Formation consists of arkosic sandstone, clay, shale, and conglomerate; yields very small quantities of water to wells. Age: Paleocene and Eocene

NON-WATER-BEARING STRATIGRAPHIC UNITS

QUATERNARY

Qb

Basalt

Flows of extrusive vesicular to dense basalt, locally includes small pumice cones

TERTIARY AND QUATERNARY(?)

QTv

Volcanic rocks

Black Mountain Basalt (Hulin, 1925), flows of vesicular to dense basalt, perlitic pumice, and rhyolite with some obsidian; generally above the water table

PRE-TERTIARY

pTb

Basement complex

Undifferentiated plutonic, hypabyssal, and metamorphic rocks; yields little or no water to wells

Irrigation acreage

Fault

Dashed where approximately located; dotted where concealed

Approximate contact

B —b—b'— B'

Line of geologic section and seismic profile

Capital letters indicate geologic section. Lowercase letters indicate seismic refraction profile

Well

SOURCE: USGS Water Supply Paper 2007, 1974

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Geologic Map

FIGURE 4-3

PAGE NO. 4-22

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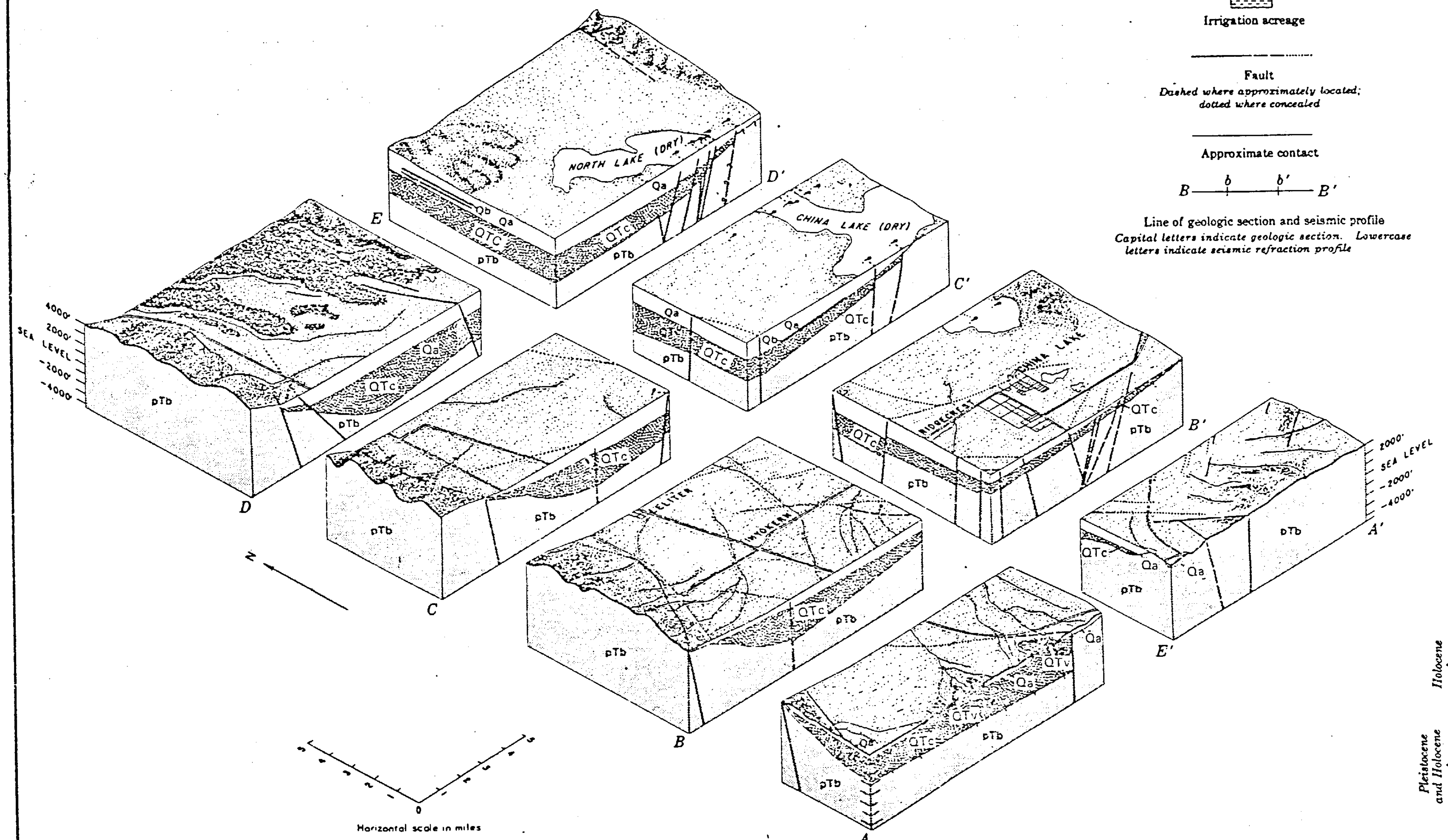

Irrigation acreage

Fault
Dashed where approximately located; dotted where concealed

Approximate contact

B — b — b' — B'

Line of geologic section and seismic profile
Capital letters indicate geologic section. Lowercase letters indicate seismic refraction profile

EXPLANATION

NON-WATER-BEARING STRATIGRAPHIC UNITS

QUATERNARY

Qb
Basalt
Flows of extrusive vesicular to dense basalt, locally includes small pumice cones

TERTIARY AND QUATERNARY(?)

QTv
Volcanic rocks
Black Mountain Basalt (Hulin, 1925), flows of vesicular to dense basalt, perlitic pumice, and rhyolite with some obsidian; generally above the water table

PRE-TERTIARY

pTb
Basement complex
Undifferentiated plutonic, hypabyssal, and metamorphic rocks; yields little or no water to wells

WATER-BEARING STRATIGRAPHIC UNITS

Holocene

Qp
Playa deposits
Unconsolidated silt and clay beneath small lakebeds; yield small quantities of water to wells, generally of poor quality

Pleistocene and Holocene

Qa
Alluvium
Unconsolidated, moderately to well-sorted gravel, sand, silt, and clay; carried moderate distance from source area; yields large quantities of water to wells

Paleocene to Pleistocene(?)

QTc
Continental deposits
Include the Coso, Ricardo, and Goler Formations
The Coso Formation consists of steeply dipping beds of white pumice, composed of particles from one-eighth to several inches in diameter, and some silt, sand and gravel; locally above the regional water table. Age: late Pliocene or early Pleistocene
The Ricardo Formation consists of moderately to highly compacted siltstone, sandstone, limestone, clay, shale, opal chert, conglomerate, tuff; yields little water to wells, generally of poor quality. Age: Pliocene
The Goler Formation consists of arkosic sandstone, clay, shale, and conglomerate; yields very small quantities of water to wells. Age: Paleocene and Eocene

SOURCE: USGS Water Supply Paper 2007, 1974

NOTE: For Cross Section Locations see Figure 4-3

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Geologic Cross Sections

FIGURE 4-4

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Andreas rift to the southwest and has a northeasterly trend as far as the south end of Death Valley.

The Wilson Canyon fault zone is a group of northwest-trending faults in the Argus Range that form a distinct graben. If the Wilson Canyon fault zone were projected northwest to Little lake, it would lie along a line of volcanic vents that were the source of the unnamed volcanic rocks in that area. According to Kunkel and Chase (1969) the Wilson Canyon fault zone may extend through the Little Lake area and the volcanic vents probably occur along this zone of weakness.

4.4.4 Hydrogeology of China Lake Complex. The major water-bearing formation in Indians Wells Valley is the unconsolidated deposits. The Naval Weapons Center, Inyokern and Ridecrest, the ranches, and all other ground water users pump water from these deposits. By 1963, more than 580 wells tapping the unconsolidated deposits had been drilled in the valley. The occurrence, movement, and storage of ground water in the unconsolidated deposits is discussed in detail by Kunkel and Chase (1969) and Dutcher and Moyle (1973). Ground water occurs in a deep aquifer, the main water body, and a shallow aquifer. The source of recharging these aquifers is precipitation that falls within the drainage areas of Indian Wells Valley, Rose Valley, and the Coso Basin.

4.4.4.1 Deep Aquifer. In addition to the wells penetrating the deep or main aquifer, which may be as great as several hundred feet thick, there are also many shallow wells in part of the valley tapping shallow fine-grained deposits. These fine grained deposits overlie extensive clay beds and lenses in the alluvium; the underlying clay beds confine the ground water in the deep aquifer.

The deep water body or aquifer occupies the central part of the valley--the approximate boundaries are the Inyo County line on the north, an east-west line approximately 2-1/2 miles south of the Weapons Center boundary on the south, the Argus fault zone on the east, the Sierra Nevada fault zone on the west, and a probable ground water barrier about 2 miles south of Inyokern on the southwest. The formations comprising this aquifer include the younger alluvium and fan deposits, older alluvium, and younger and older lacustrine deposits. The bottom of the system is considered to be the base of the older alluvium. The thickness is probably 1000 feet beneath most of the central valley area.

In most of the valley, this aquifer is considered to be under unconfined conditions. However, in the eastern part of the valley, beneath China Lake and the area covered by windblown sand and interdune playa deposits, this aquifer is confined by impermeable clay of the younger and older lacustrine, and playa deposits. The area, where the aquifer is confined, is north of a somewhat irregular and ill-defined line labeled the China Lake Barrier extending from the Weapons Center main gate to Sandquist Spa and east of a line extending north from the Spa. (This is discussed later and shown on Figure 4-6 in Section 4.4.4.3.) South and west of this line, the aquifer is largely unconfined.

Where the aquifer is unconfined, the water is generally of good quality. Locally, in the area southeast of Ridgecrest, there are areas where the unconfined zones in the aquifer contain brackish to highly saline water. In the area where the aquifer is confined, the water is generally of poor quality; and in the deepest part of the aquifer, the water is reported to be extremely saline.

4.4.4.2 Shallow Aquifer. The shallow aquifer lies above the deeper confined aquifer in the area surrounding China Lake. The base of the shallow aquifer is poorly defined, but is roughly between 50 and 150 feet below land surface. Locally, appreciable differences in water-level elevations exist between wells tapping the shallow and deeper aquifers. According to Kunkel and Chase (1969) wells tapping the shallow aquifer at 50 to 150 feet in depth will probably penetrate clay of very low permeability. In addition to clay, this formation contains occasional lenses of sand or sand and clay. The aquifer yields water in very small quantities, has a lower head than nearby deeper wells that are drilled into the confined part of the main water body.

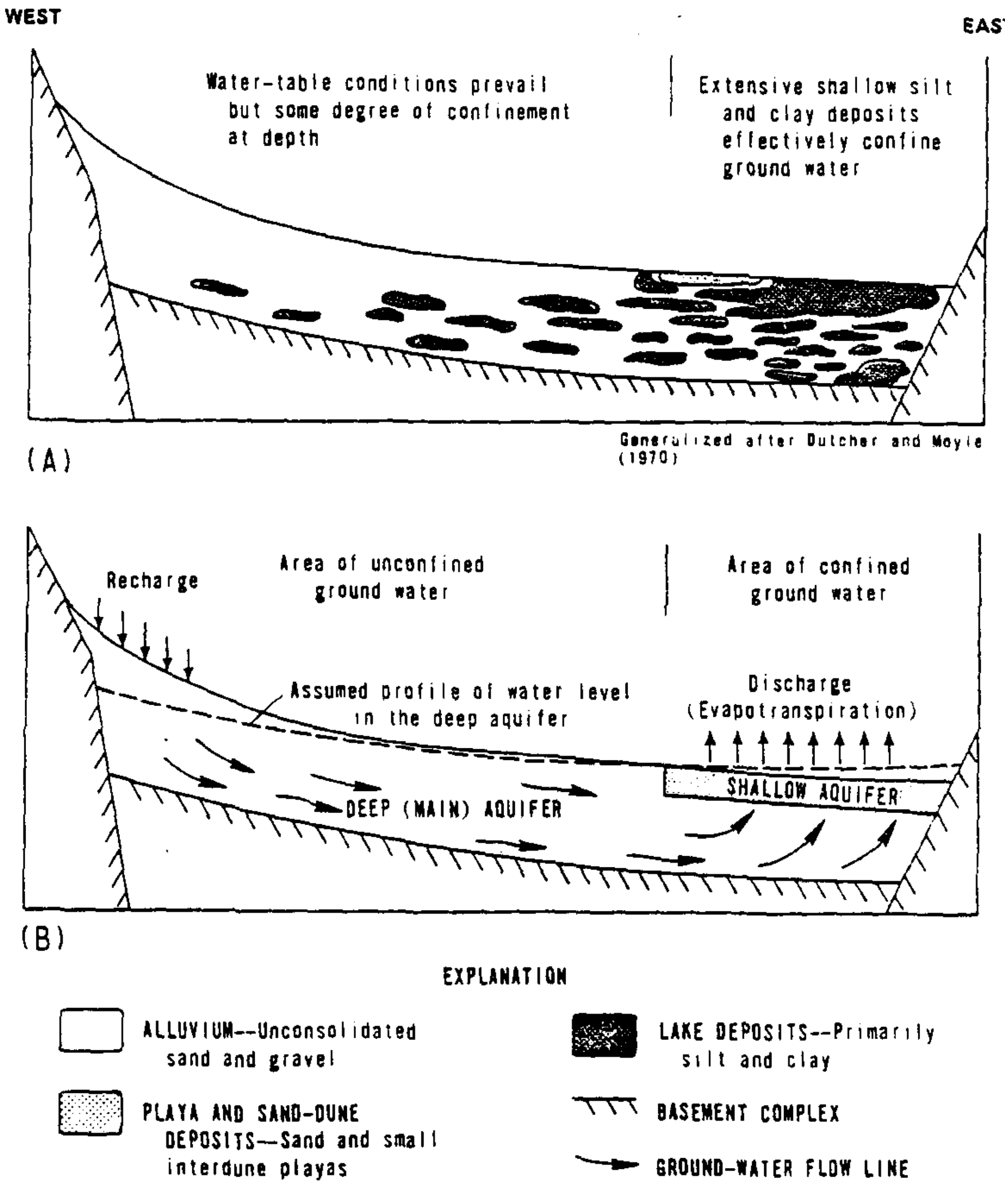
Due to the confining bed, the shallow and deep aquifers have poor hydraulic interconnection. However, as the head in the shallow zone is lower than the head in the deep aquifer, upward leakage will occur from the deep aquifer to the shallow aquifer. The rate at which water moves upward from the deep aquifer to the shallow aquifer is slow due to the low permeability of the confining layer.

4.4.4.3 Ground Water Flow System. The generalized flow system for this type of environment is shown in Figure 4-5. The upper portion of this figure illustrates a cross-section where the geologic conditions in the upper formation grades into a fine material such as silt and clay. The bottom section illustrates the effects of the gradation on the flow system, from the recharge area on the left, where the aquifer is under unconfined conditions, to the discharge area on the right, where the aquifer is under confined conditions. The water is being discharged from the shallow aquifer to the atmosphere through evapotranspiration. At the same time, the water from the deeper aquifer is migrating vertically upward to recharge the shallow aquifer. This discharge area, for both aquifers, is equivalent to the area of the China Lake Playa.

Ground water flows from the source of recharge or an area of high energy (head) toward an area of discharge or low energy (head). The value of head of a ground water body is shown by the altitudes of the water levels in wells; hence, water-level contours or lines connecting points of equal head can be drawn to illustrate the configuration of the water table or potentiometric surface. Ground water flow is perpendicular to these contour lines and toward points of lower head.

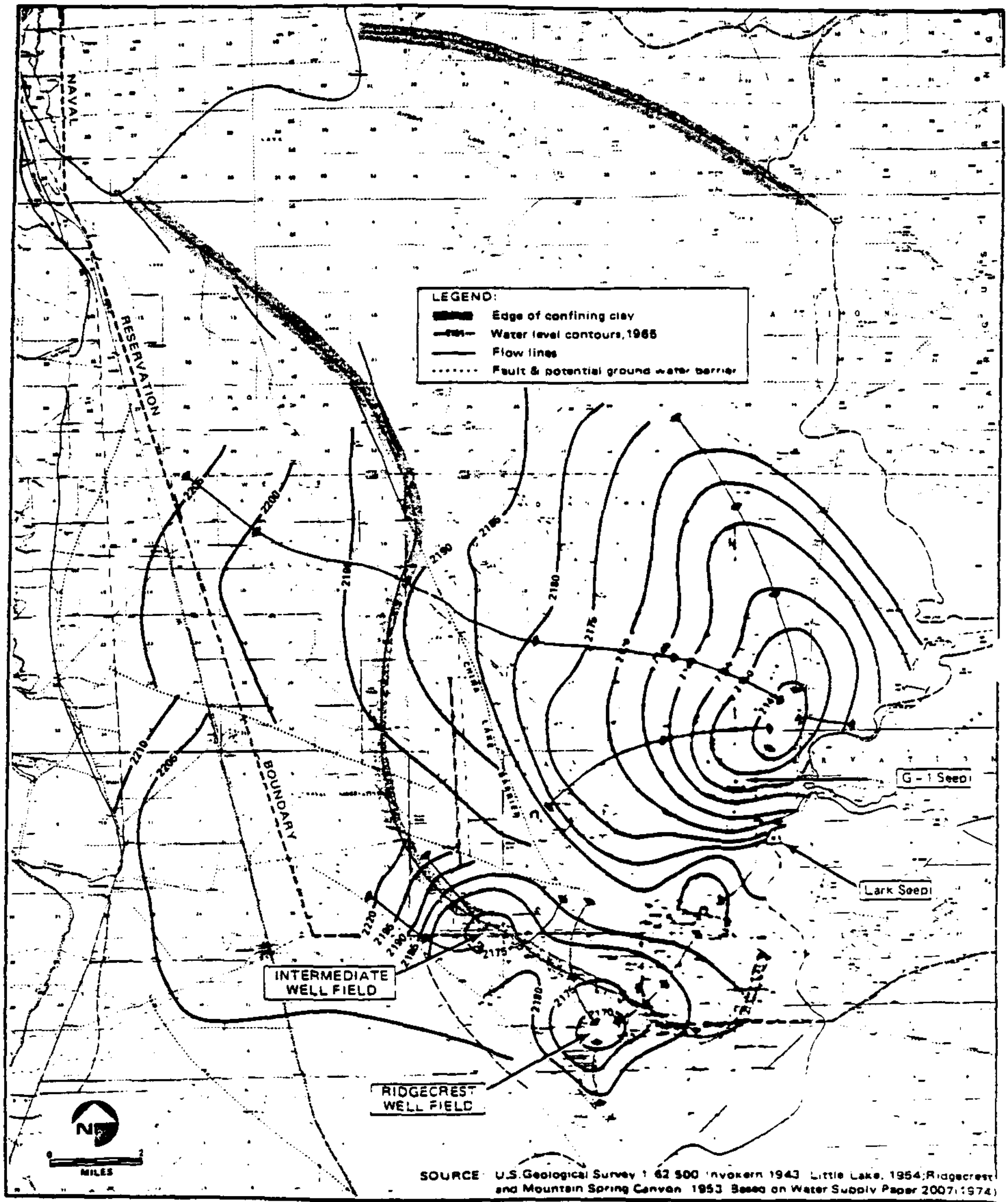
Figure 4-6 illustrates the configuration of the water table and/or the potentiometric surface for the deep aquifer. The flow system at China Lake is complicated. It is composed of a deep and shallow aquifer, however there are also faults that act as barriers to ground water flow.

The flow patterns in the central part of the valley, north of Armitage Field, are basically from west to east. The recharge areas are in the alluvial fans near the mountains and the major natural discharge area is the China Lake Playa. Flow is also towards the well fields as shown in Figure 4-6. The well fields (called Intermediate and Ridgecrest) are shown by closed depressions on the map. The only large closed depression shown on the map is due to the major ground water discharge through China Lake Playa. As the flow from the west nears the SNORT track, the lower aquifer becomes confined by low permeability material while the water-bearing alluvial material above the confining bed remains under unconfined conditions. However, the heads in the deeper aquifer are greater than the heads in the shallow aquifer. Therefore, water from the lower aquifer



SOURCE: Generalized after Dutcher and Moyle (1970)

INITIAL ASSESSMENT STUDY NAVWPNCEN, CHINA LAKE	Conceptual Cross Sections of Geologic and Flow Conditions	FIGURE 4-5



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Water Level Contours 1965

FIGURE 4-6

migrates to the upper aquifer. The China Lake Playa is a major regional discharge area, that is, water from both aquifers are discharging in this area through evapotranspiration.

South of this discharge area, between the Burroughs High School and Richmond School, (both in the town of China Lake) a barrier fault exists. This is shown in Figure 4-6 as a dotted line. Dutcher and Moyle (1973) and Kunkel and Chase (1969) report that the ground water in the deep aquifer cannot flow across this barrier. This is shown on the map by abrupt changes in the contour line patterns. Flow north of the barrier is migrating towards the China Lake Playa; flow south of the barrier is migrating towards the major pumping centers at Ridgecrest and at the Intermediate Well Field.

In addition to patterns of flow, the depth-to-water can affect the migration of contaminants. The depth to water has been estimated and shown on Figure 4-7. The area labeled I is limited on the west and south by the contact of the fan deposits and younger alluvium. The depth to water is about 100 feet on the east and about 220 feet on the west.

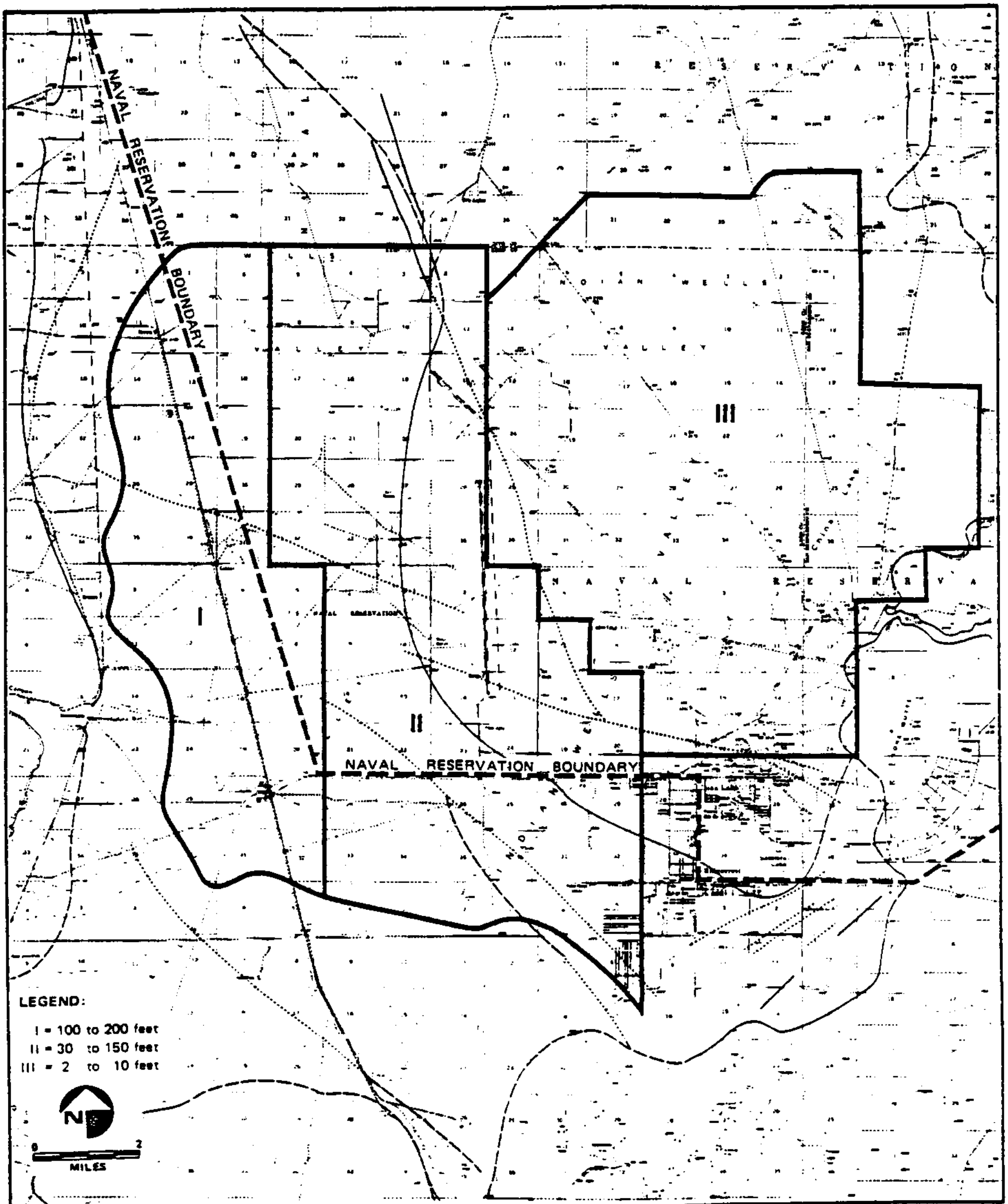
The area labeled II extends from the east limit of I towards the area where ground water is shallow. The average depth to water ranges from about 150 feet for the south part. On the east, this area is bounded by area III. In Area III, the depth to water is very shallow, generally ranging from about 2 to 10 feet but being as much as 30 feet in the southwest portion near Area II (Leedshill-Herkenhoff, 1983).

In order to determine the potential rate of containment migration, the aquifer coefficients are estimated. The transmissivity has been estimated by Dutcher and Moyle (1973), and Kunkle and Chase (1969) to be betwen 200,000 and 300,000 gallons per day per foot (gpd/ft). To estimate the hydraulic conductivity, the saturated thickness is assumed to be equivalent to the section of aquifer the wells are tapping. In this area the wells are perforated between 500 and 900 feet. Therefore the hydraulic conductivity is estimated to range between 500 and 750 gpd/ft^2. Leedshill-Herkenhoff (1983) has carried out slug tests at Armitage field and interpreted hydraulic conductivities to range from 2 to 6 x 10^{-3} centimeters per second (cm/sec), which is equivalent to approximately 40 to 130 gpd/ft^2. Therefore, for purposes of this report, a conservative value of hydraulic conductivity would be 500 gpd/ft^2 (2.36 x 10^{-2} cm/sec). The porosity is estimated at 25 percent and the hydraulic gradient is measured to range from 0.00095 to 0.0019 and average 0.001. The velocity (v) can be estimated from the hydraulic gradient (k), the gradient (I), and the porosity (n) by the following relationship:

$$v = \frac{kI}{n}$$

Therefore the average velocity of ground water flow can be estimated to be 0.27 feet per day or about 100 feet per year.

A factor adding to the complicated situation of the ground water flow system is the change in the shallow flow system near the China Lake barrier near Ridgecrest. The establishment of the Naval Weapons Center at China Lake and the growth of the town of Ridgecrest have resulted in heavy ground water pumpage. This heavy pumpage along with recharge to the ground water system of sewage



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Approximate Depth to Ground Water

FIGURE
4-7

effluent has changed local ground water flow patterns, but differently in the two aquifers. A water-level contour map (Figure 4-8) was constructed for both the deep aquifer and the shallow aquifer for 1972 to depict these local conditions.

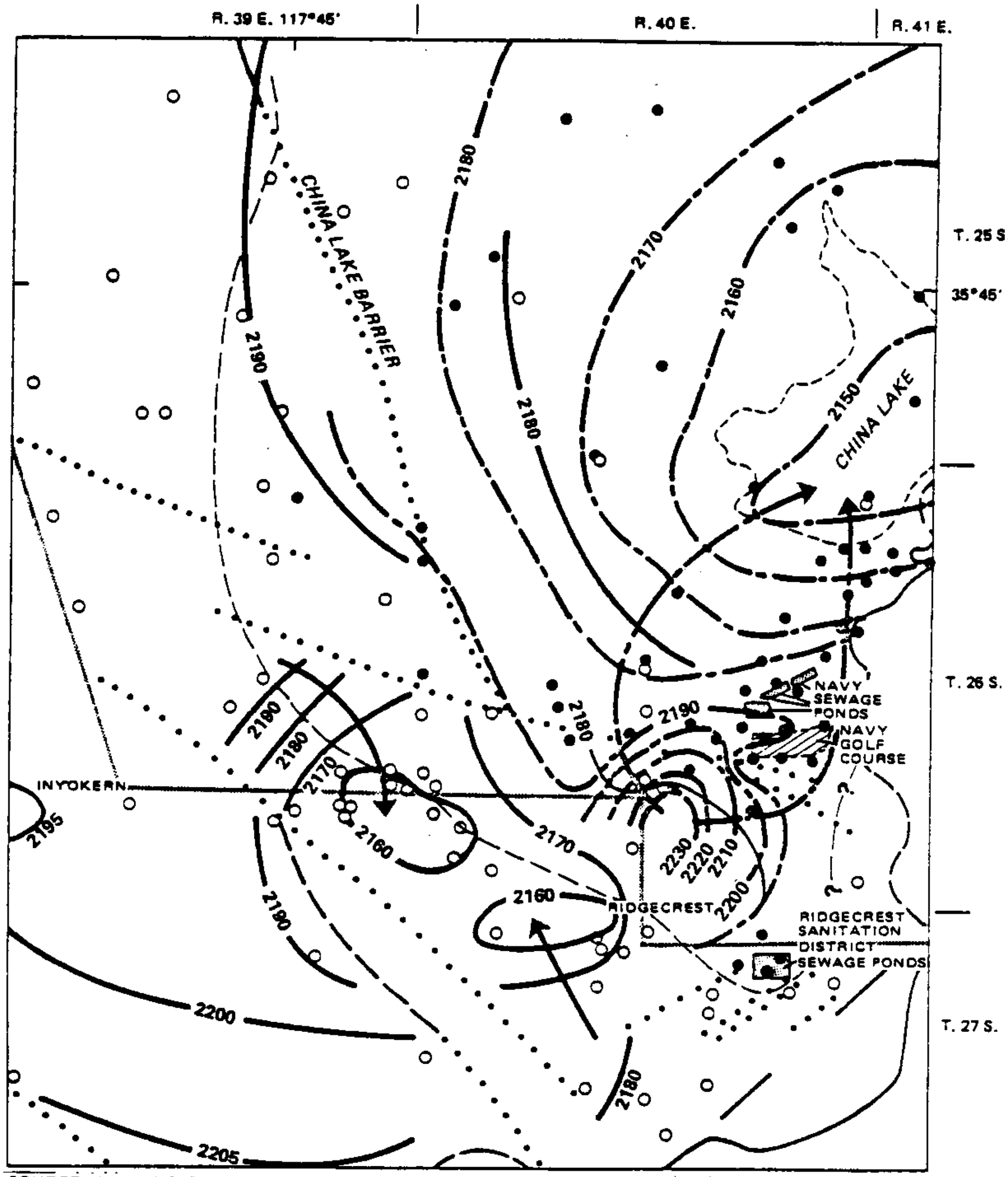
In a model study by Bloyd and Robson (1971), the model-generated water-level contours for the deep aquifer for 1968 indicate that a barrier to ground water flow exists in this area. This boundary is the China Lake barrier. Flow north of the barrier is towards the Playa and flow south of the barrier is towards the well field. The study also suggests that south of the China Lake barrier ground water in the deep aquifer is no longer confined because pumping in the Intermediate and Ridgecrest well fields has caused the potentiometric surface to fall below the confining clay beds, thus producing water-table conditions. Therefore, the deep aquifer does not discharge into the shallow aquifer in this area. It was conjectured by Bloyd and Robson (1971) that the southern and western extent of the shallow aquifer coincided with the China Lake barrier because the deep aquifer is the only significant natural source of recharge to the shallow aquifer.

Because of the paucity of data for the shallow aquifer, the effects of recharge of effluent from the Navy sewage ponds were unknown. Recharge of this effluent was suspected to have reversed the natural ground water flow in the shallow aquifer across the China Lake barrier and to have reversed the natural movement of ground water between the deep and the shallow aquifers. Reversal of natural ground water flow in the shallow aquifer across the barrier would cause the native poor-quality water to migrate southwestward toward the pumping depressions in the Intermediate and Ridgecrest areas. Potentially, this condition could degrade the water there to such an extent that it would not longer be suitable for use as a public supply.

According to Warner (1975), 27 shallow wells were augered in the vicinity of the Navy sewage ponds, in the area adjacent to the China Lake barrier, and in the area east of Ridgecrest near the Ridgecrest sewage ponds. Data from these wells indicated that not only is the shallow aquifer present in the area between the edge of the confining zone and the China Lake barrier, but that a recharge mound exists in this area, centered near Sec. 27, T. 26 S., R. 40 E. (Figure 4-8). This mound is apparently not related to the Navy or Ridgecrest wastewater ponds. The explanation for the existence of this mound is given below.

Warner (1975) indicates that in the area of this mound, the differences in water level between the shallow and the deep aquifer are exemplified by the difference in water levels between individual wells. Warner (1975) has found that the head in the deep aquifer is about 50 feet lower than in the shallow aquifer. The most plausible explanation for the higher head in the shallow aquifer is local recharge from watering of shrubbery and leakage from water and sewer lines. This mound maintains the natural northeast direction of flow in the shallow aquifer across the fault toward the China Lake playa. The water-level contour map for 1972 (Figure 4-8) indicates that recharge from the Navy sewage ponds has not reversed the natural direction of flow in the shallow aquifer across the fault.

The digital-model study (Bloyd and Robson, 1971) indicated that the China Lake barrier is a very effective barrier to ground water flow in the deep aquifer



SOURCE: Warner (1975) USGS Water Resources Investigations 8-75. Based from U.S.Geological Survey Topo.Maps.

LEGEND

Boundary of ground-water basin. Dashed where control is poor

Boundary of shallow aquifer and assumed limit of confining clay layers. Queried where location inferred

Faults: dashed where approximately located, dotted where concealed

2200 Water-level contour for deep aquifer Contour intervals 5 and 10 feet (1.5 and 3.0 metres); datum is mean sea level

2160 Water-level contour for shallow aquifer Contour interval 10 feet (3.0 metres); datum is mean sea level

Well used in construction of water-level contours for deep aquifer

Well used in construction of water-level contours for shallow aquifer

Flow Line

Naval Reservation Boundary

N

0 2 MILES

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NAVWPNCEN, CHINA LAKE

Water-level Contours for 1972

FIGURE 4-8

only. Data from the present study strongly suggest that the fault does not affect ground water flow in the shallow aquifer. There is no apparent surface expression of the fault in this area, and it probably does not affect the sedimentary deposits near the land surface. The unfaulted sedimentary deposits apparently extend across the fault and seem to allow water in the shallow aquifer to flow across the fault without interruption. Because the China Lake barrier apparently is not an effective barrier to ground water flow in the shallow aquifer, it is especially important to maintain the natural direction of flow across the fault toward the China Lake playa to prevent the poor-quality water in the shallow aquifer from migrating toward the pumping depressions in the Ridgecrest and Intermediate well fields.

4.4.5 Hydrogeology of the Mojave "B"/Randsburg Wash Complex. Recharge to the ground water body in the Mojave "B"/Randsburg Wash complex occurs by direct infiltration of rain, subsurface flow from the adjoining areas, and percolation of the infrequent runoff that occurs during flash floods from the surrounding mountains.

Panamint Valley in the north Mojave "B" Range is a closed structural basin. From the meager data available, it is the opinion of the California Department of Water Resources that no water entering Panamint Valley escapes except by evaporation. Only a small quantity of ground water is being pumped. Water in Panamint Valley beneath South Panamint dry lake is very salty, containing as much as 272,000 parts per million (ppm). In some places freshwater can be obtained from shallow wells near the edge of the dry lake, but in general most water produced from deep wells is salty.

Only two wells have been drilled in the Pilot Knob Valley (Randsburg Wash) area which are owned by the U.S. Navy. Pump tests on these wells indicate that the transmissivity of the aquifer in this area is very low--about 1000 gallons per day per foot. The ground water gradient is very flat and appears to slope to the northwest. The low gradient and transmissivity indicate that the quantity of ground water moving through the aquifer is small and that under natural conditions the recharge and discharge to the aquifer is probably not more than about 100 acre-feet per year.

The Garlock Fault is located along the north side of the aquifer and acts as a barrier to the movement of ground water. Water-level data for wells suggest that water levels may be as much as 400 feet lower on the north side of the fault than on the south side.

The aquifer near Randsburg Wash covers an area of about 30 square miles. The amount of recoverable water in storage depends on the saturated thickness of the aquifer, and its ability to release water from storage. Lack of well data precludes an appraisal, although estimates of storage can be made, based on hydrologic experience elsewhere. However, of more importance, is the ability of the aquifer to yield sufficient quantities of water to wells. Its low transmissivity makes recovery of this water difficult as well yields are small.

In the southern segment of the Mojave "B" Range about 1000 head of cattle are grazed under an ephemeral lease. The lease is administered by the Bureau of Land Management and water is mined by wind-powered pumps from fresh water reservoirs formed by subsurface sands and gravels of dry Superior Lake to the south.

4.4.6 Springs and Seeps. There are no perennial streams or lakes on NAVWPNCEN lands. A total of 49 springs and seeps have been identified on the China Lake Range area of NAVWPNCEN. There are a few fresh water springs along the western edge of the Coso Range. Most occur above the 6000-foot level in the central area of the Cosos. Numerous springs occur in the Argus Range between Argus and Maturango Peaks. There are two environmentally sensitive seeps. These are named the lark and G-1 seeps and are located in Figure 4-2. These seeps and a ditch connecting them contain the Mohave chub, an endangered species.

Water is extremely scarce in the Mojave "B"/Randsburg Wash Ranges. A few perennial springs exist in the Slate Range of the North Mojave "B" area. No springs and only a few seeps occur in the Randsburg Wash area. The southeast sector of the Mojave "B" area contains a few ephemeral springs. About a half dozen springs occur in the southwest sector of the Mojave "B" area.

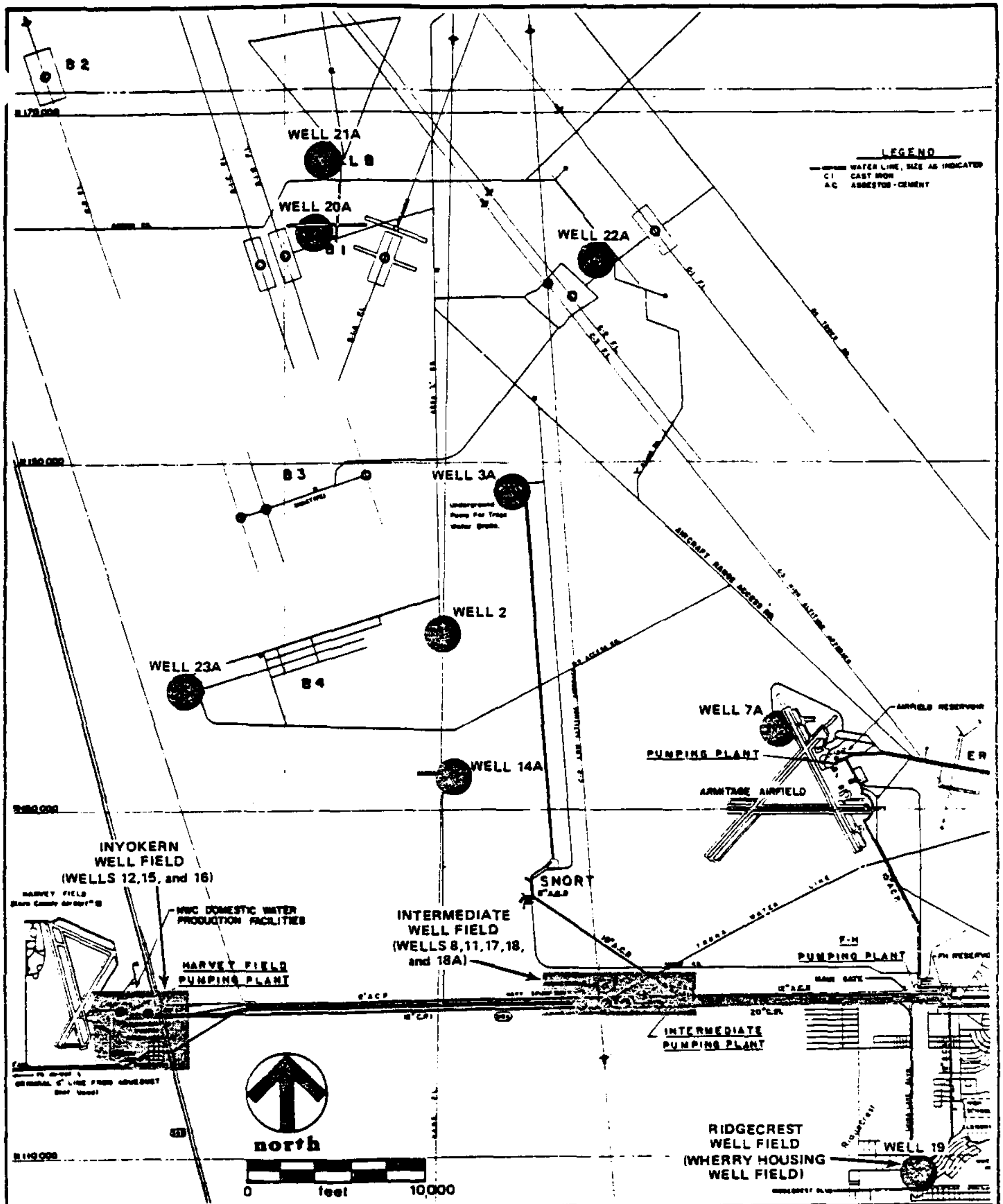
4.4.7 Soils. The soils at China Lake are presently being described and mapped by the Soil Conservation Service. In general the soils are considered as coarse textured material with cemented zones appearing at depths from 5 to 18 feet, underlain by sand (light brown decomposed granite). The surface soils are deficient in nitrogen and high in salt accumulation. Soils found at Armitage Airfield are classified as silty sands. Except for the loose surface deposits, the soils are dense and compact. At the Range Operations Center near the China Lake Playa, the soils are predominantly silts and clays. Core samples from this area exhibit very low dry density and high moisture content. Specific soils investigations are required at all proposed project sites considered for development.

4.4.8 Water Use. In 1912 it has been determined that eight production wells existed, pumping about 2000 acre feet (St. Amand, 1984). The amount of pumping has continued to increase, until the estimated amount of water pumped is 26,494 acre feet in 1979. The water use in 1979 is shown on Table 4-3.

The NAVWPNCEN domestic water pumping and distribution systems provide potable water to the NAVWPNCEN work areas. Fire protection water for most areas is provided directly by the potable water system. The main domestic water system was described in a report by George S. Nolte and Associates (1978).

The potable water system in the China Lake Complex includes the main NAVWPNCEN domestic water system serving the major NAVWPNCEN work areas, and the small separate water systems which serve the remote range areas. The water system is shown on Figure 4-9.

The main NAVWPNCEN water system is more than 20 miles long. Water must be pumped from the western sources of better quality water east to the NAVWPNCEN headquarters and the China Lake Community and then further east to service the other main work areas in Salt Wells Valley. The main distribution system was constructed in 1945-46. The water system has been expanded since then by alterations in the 1950s and 1960s. A connection to the Los Angeles Department of Water and Power Aqueduct in the original system has since been abandoned.



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Locating Wells and Water Supply System

FIGURE 4-9

Table 4-3

Water Use in 1979 (St. Amand, 1984)

PRODUCER	ACRE FEET
WILBUR STARK WATER CO.	993
NAVAL WEAPONS CENTER	5,370
INDIAN WELLS VALLEY WATER DISTRICT	3,402
SEARLES VALLEY WATER USERS	3,100
ANTELOPE VALLEY WATER COMPANY	429
HOUSEHOLDERS (ESTIMATED)	500
AGRICULTURE (ESTIMATED FROM ALFALFA ACREAGE)	9,700
SAW MILL	3,000
TOTAL PUMPAGE	26,494

The NAVWPNCEN water is derived mainly from four wells, which form the NAVWPNCEN Domestic Water Production Facilities, located at Harvey Field, the County Airport at Inyokern, 8 miles west of the NAVWPNCEN Main Gate. This well field is also known as the Inyokern well field. Three other wells are located 4 miles west of the Main Gate near the Intermediate Pumping Plant. In fiscal year (FY) 1979, the annual water production from the NAVWPNCEN wells was 1024 million gallons. The peak production was 10 million gallons per day.

The water from the Domestic Water Production Facilities at Harvey Field is transferred east to the Intermediate Pumping Plant, where water from three adjacent wells is also collected. The water at the Intermediate Pumping Plant can be transferred to the NAVWPNCEN headquarters and the China Lake Community (FH area) reservoirs, or else pumped directly to the B Mountain reservoirs (west side of B Mountain). The FH reservoirs are nearly 160 feet lower than the Harvey Field Pumping Plant. Small demands for water can be delivered by gravity flow. Delivery of larger demands is made using the pumps to augment the flow rate. The Intermediate Pumping Plant includes a hydropneumatic system supplying water to the SNORT track for possible domestic uses, and for the track water brake system. The FH Pumping Plant supplies the NAVWPNCEN headquarters and the China Lake Community, Armitage Airfield, including a storage reservoir for the airfield deluge fire pump system, and nearby range areas to the north.

Both the Intermediate Pumping Plant and the FH Pumping Plant can transfer water to the B Mountain reservoirs, which determine the operating pressure of the FH system. The B Mountain Reservoirs also supply water to Booster Stations 1 and 2 which operate in series, pumping water over B Mountain to the Pilot Plant Reservoirs. Water flows from these reservoirs through pressure regulating valves to enter the China Lake Propulsion Laboratory (CLPL) system. It then flows through pressure reducing reservoirs to serve the Salt Wells Propulsion Laboratory (SWPL), the T range and the CT range test areas. Water then enters the CT reservoir. Booster pumps at the reservoir transfer the water up to the Skytop Propulsion Test Range in the far southeast corner of the China Lake Complex. The Skytop area is served by a small hydropneumatic system.

In addition to the main well field discussed above there are eight other wells that may be used to produce water at the NAVWPNCEN. All of these wells are located west of Armitage Field as shown on Figure 4-9. These wells include W-2, 3A, 7A, 14A, 20A, 21A, 22A, and 23A. Of these, Baker One (W-20A), Love-Baker (W-21A), Charlie Range (W-22A), and Baker Four (W-23A) are being used for landscaping and/or potable water supplies. The other wells can be used if the area became active.

Randsburg Wash has two wells that are being used for potable water supply (Dodson, 1984). The depth to water in these wells is greater than 250 feet.

4.4.9 Natural and Geologic Hazards.

4.4.9.1 Seismic Hazards. Analysis of seismic potential is based on an understanding of local and regional structural geology, the identification and delineation of faults, and consideration of the history of seismic activity. Faults with recent activity of large magnitude, such as the Owens Valley fault always have been considered more significant in analysis of seismic potential than faults without historic activity. However, the period of recorded seismic history in southern California (200 years) is very short, and may be an inadequate base for interpreting future activity. It is intersting to note that almost every event of Richter magnitude greater than six in southern California has occured on a fault lacking historic activity. (Earthquakes on the San Jacinto and Imperial Valley faults are exceptions.) For planning purposes, faults are classified as "active," if they show displacement within the last 10,000 years (Holocene period).

The China Lake Complex lies in one of the more seismically active areas in California. Small earthquakes occur throughout the Indian Wells Valley and in the surrounding hills. The great regional earthquake in Owens Valley (1872) damaged adobe structures in the Indian Wells Valley. More recently, a magnitude 5.0 earthquake occurred in September 1938, directly south of the location of the NAVWPNCEN headquarters area. The last major earthquake occurring in the vicinity of the Indian Wells Valley was the magnitude 6.3 earthquake which took place in Walker Pass in March 1946. The earthquake was strongly felt at NAVWPNCEN, although it did no damage. Between the years 1934 and 1963, energy equivalent to about 20 magnitude 3.0 earthquakes per 100 square kilometers has been released in the Indian Wells Valley (St. Amand, 1984).

4.4.9.2 Stormwater Flooding. Stormwater flooding has been a significant problem for the developed area at the China Lake Complex. The outlying range areas in the China Lake and Randsburg Wash/Mojave "B" Complexes are also affected by flooding from seasonal runoff; however, floods in these areas have caused less damage since there is less existing development.

The NAVWPNCEN headquarters, the China Lake Community, and the City of Ridgecrest are located in the Indian Wells Valley which serves as a drainage basin for the surrounding mountains. The major washes which run through Ridgecrest and then through NAVWPNCEN originate in the El Paso Mountains to the southwest. The washes of the Ridgecrest-NAVWPNCEN area are poorly defined with small capacities and coalescing alignments.

Ridgecrest Wash and El Paso Wash drain to the China Lake playa north of the NAVWPNCEN headquarters and the China Lake Community. Ridgecrest Wash enters NAVWPNCEN near the Main Gate and runs northeast through the Laboratory Area towards China Lake. El Paso Wash crosses Inyokern Road (Highway 178) (about 2 miles west of the Main Gate) and runs east of the airfield towards China Lake. As reported, excess water in El Paso Wash from major storms in the past has tended to flow east along Inyokern Road to increase the flow in Ridgecrest Wash. Two such storms, in 1963 and 1964, caused damage to NAVWPNCEN administrative and laboratory facilities. In addition, some flooding occurred in 1983 especially in the SWPL area.

A series of small unnamed washes drain to the Satellite Lake and Mirror Lake playas east of the NAVWPNCEN headquarters and the China Lake Community. Flows in these washes in the past have resulted in some flooding of NAVWPNCEN housing areas.

4.5 ENVIRONMENTAL PROPERTIES AFFECTING MOVEMENT OF CONTAMINANTS. This discussion examines in a general way the potential for migration of contaminants expected to be present in soils of some areas at the China Lake Naval Weapons Center. Data from previous studies have been used to identify compounds and groups of compounds both organic and inorganic in nature which are present in soils at a variety of locations at the facility. Physical properties including aqueous solubility, vapor pressure, boiling points, freezing points and polarity were used in conjunction with chemical properties of each compound or group of compounds to identify predominant pathways for transport of each compound to the environment via the local ground water system. Following identification of dominant migration pathways, each compound or group of compounds was examined with respect to concentrations and relative travel times for contaminants to reach ground water and how these contaminants would be transported in local ground water. Rates of contaminant migration in the ground water system are also discussed.

From previous studies and information gathered in this IAS the following compounds and/or groups of compounds have been identified as soil contaminants potentially present in significant concentrations at some sites:

- Pesticides (including chlordane and DDT)
- Solvents
- Explosive compounds (TNT and RDX)
- Jet fuels
- Diesel fuels
- Propellants (solid and liquid)
- Heavy metals (from chemical and photographic laboratories)
- Acids (from chemical laboratories)

The rate of migration of the above compounds at a specific location is strongly dependent on a variety of soil and ground water properties. These properties include:

- Soil pH
- Soil minerals present (clays, metal oxides)
- Soil organic matter (type and concentrations)
- Ground water pH (including unsaturated zone water)
- Chemical characteristics of ground water
- Depth to ground water
- Rate of ground water flow
- Rate of rainwater infiltration
- Site stratigraphy

In general, unsaturated zone soils at the facility are alkaline in nature and may contain an abundance of salts near the surface or in caliche zones due to the arid environment. Concentrations of soil organic matter are low and concentrations of clay minerals are moderate. The quality of the neutral to alkaline ground water is relatively poor with high total dissolved solids. Total dissolved solids of these concentrations will enhance transport of inorganic contaminants by complexation phenomenon. With the variables of the soil ground water system fairly well defined, with the exception of depth to ground water, the specific contaminants will be examined. As depth to ground water is perhaps the single most important factor in calculating the period of time necessary for a contaminant to reach the ground water system a comment regarding this variable is necessary. Depending on the location of contaminant sources at China Lake, depth to ground water may vary from less than 5 feet in the region of the sewage evaporation ponds to an excess of 200 feet in other portions of the facility. The subsequent discussion has not considered exact locations of contaminants but discusses relative migration from a hypothetical contaminant source location.

4.5.1 Pesticides. Pesticides vary considerably in their composition, volatility, water solubility, and therefore in their mobility. The two compounds of primary concern, chlordane and other pesticides like DDT, are similar in molecular structure, both being organochlorine pesticides. In general, both pesticides are very insoluble in water with maximum solubilities in the low parts per billion range. Chlordane is significantly more volatile than DDT with average retentions in near surface soils of 55 percent and 80 percent for 1 year respectively. Chlordane is considered volatile while DDT is considered slightly volatile. However, in a subsoil/ground water environment mobility is controlled by aqueous solubility and attenuation by soils. Both chlordane and DDT are ranked in the lowest mobility class of all common pesticides due to their low aqueous solubility. Other organochlorine pesticides including heptachlor, aldrin, and endrin exhibit similar mobility due to similarity in structure and aqueous solubility. In summary, both chlordane and DDT are relatively immobile in all soils due to low solubility and the attenuative capacity of local soils which are moderately rich in clay minerals.

4.5.2 Solvents. In general, solvents, usually halogenated organic compounds, have high aqueous solubilities and exhibit limited attenuation by soil minerals. Therefore, once solvents have reached the ground water table their rates of migration approach transport rates for conservative species such as chloride. It is understood that some solvent compounds, such as TCE, may in fact travel faster in ground waters than conservative species like bromide or chloride due to lower attenuation than these species. Diffusion and dispersion of solvents once in the ground water system may reduce concentrations by dilution, but the process which will dominate effective times for solvents to reach receptors is the time necessary for these compounds to reach the water table.

In an arid region, such as the China Lake area, considerable solvent may be retained in unsaturated zone soils for considerable periods of time by surface tension effects. As with contamination by jet or diesel fuels the solvent compounds (light hydrocarbons) will be dissolved and will move with percolating rainwater to the water table. If, however, only severe storm events penetrate the upper few feet of soil and the unsaturated zone thickness is on the order of 100 feet, not atypical at China Lake, these compounds may be retained within the unsaturated zone for a number of years prior to dissolution in ground water. However, once these compounds reach ground water they are extremely mobile.

4.5.3 Explosive Compounds. The explosive compounds of specific interest at China Lake are TNT and RDX. Processes controlling migration of 2, 4, 6 TNT and RDX are aqueous solubility, adsorption by soil minerals, and biodegradability. Solubilities of TNT and RDX are approximately 130 mg/l and 65 mg/l respectively at 20°C. Dilution effects will prevent ground waters from approaching these maximum concentrations. Clay minerals present in the unsaturated zone will exhibit relatively high attenuative attraction for TNT and considerably less for RDX.

Biodegradability of TNT is well documented and by-products of TNT degradation include other nitrated aromatics (1, 3 DNB, 2, 4 DNT, 2, 6 DNT, and 1, 3, 5 TNB). Degradation occurs by loss of either a nitrate or methyl group from 2, 4, 6 TNT (trinitrotoluene). RDX has been found to be little affected by the presence of microbes. In combination with observed migration rates approximately twice that of TNT, RDX, which remains unaffected in the unsaturated zone and in ground water, will be more mobile than TNT or its degradation products. Documented experimentation yielded data suggesting that RDX may be as mobile as the nitrate ion confirming that soil minerals have little attenuative capacity for RDX.

To summarize, TNT is readily degraded to other nitro aromatic compounds and is moderately well attenuated by soil minerals (predominantly clays). RDX, however, does not readily degrade and exhibits little attenuation, resulting in faster travel times within the unsaturated zone and within the water table.

4.5.4 Jet and Diesel Fuels. Relatively large volumes of jet fuels and diesel fuels have contaminated subsurface soils. The degree of ground water contamination and the compounds present in local ground water depend on the volumes of fuels, the area over which these fuels were disposed of, the unsaturated zone thickness, and hydrologic properties of the unsaturated zone.

If the volume of fuel can be absorbed in the unsaturated zone without forming a discrete layer of petroleum floating on the water table then contamination by the fuel will occur over a relatively long period of time in conjunction with percolation of rain water. Water soluble compounds such as benzene and toluene will be transported to the water table at a rate faster than less soluble, heavier hydrocarbons. Aliphatic components which dominate the fuel compositions tend to break down in the environment much more readily than the minor component aromatics like benzene and toluene.

If the volume of fuel disposed of totally saturates the unsaturated zone beneath the disposal area a discrete layer of petroleum product will be present floating on the water table. The hydrocarbon layer in the form of a lens will migrate partially upgradient but predominantly downgradient. In addition, water soluble compounds will be partitioned into the ground water and migrate as dissolved contaminants. Rates of contaminant migration are dependent upon the specific compound's properties, ground water flow rate, and soil minerals present.

4.5.5 Propellants. Propellants which are petroleum based will exhibit migration properties as described above under jet and diesel fuels. Propellants which are solid, specifically beryllium, will exhibit different mobility. Although beryllium use on NAVWPNCEN was limited, some detail is provided here because its properties had to be considered when evaluating some past disposal sites for the chemical on NAVWPNCEN. Beryllium is very insoluble in most environments of soil/ground water and is strongly attenuated by clay minerals, metal hydroxides, and organic matter due to its small charged ionic nature. Typical surface water concentrations of beryllium are less than 1 ppb. Transport of beryllium is thought to occur by formation of a fluoroberyllate complex. Chloride complexation which usually enhances a metal's solubility, is not stable and, therefore, soil/ground water systems which have high fluoride will exhibit the strongest migration potential for beryllium. Upon consideration of migrational processes that are dominant at China Lake the potential for beryllium migration, especially in small volumes, is low due to low solubility and strong attenuation by soil minerals.

4.5.6 Heavy Metals. Heavy metals are expected to be contributed to the soil/ground water system from both laboratory and photographic wastes. Metals of primary concern would be silver (Ag), arsenic (As), chromium (Cr), lead (Pb), copper (Cu), and possibly zinc (Zn). In the soil environment present at China Lake most of these metals will be relatively insoluble. Specifically Pb, Cu, and Zn are very insoluble at alkaline pHs. However, if acids were disposed in the same area or metals were disposed of in acid solution the potential for transport would be greatly increased. As is the case for most contaminants the greater the unsaturated zone thickness the slower the transport process will be due to strong attenuation of these three metals (Pb, Cu, Zn) by soil minerals.

Chromium and arsenic exhibit aqueous properties different from Pb, Cu, and Zn. These metals form anionic (negatively charged) complexes with oxygen and have relatively low charge densities. Due to the large ionic size and negative charge these metals are not strongly attenuated by clay minerals. The formation of such complexes also increases aqueous solubility and therefore these metals have a much higher potential for transport than most other heavy metals. Iron oxides, at neutral soil pH, do retain a net positive surface charge and, therefore, do attenuate both arsenic and chromium. The concentration of iron oxides and specific mineralogy will determine the degree to which attenuation occurs. However, in general, arsenic and chromium are very mobile. Hexavalent chromium is the chromium oxidation state of greatest concern as it is significantly more toxic than trivalent chromium at identical concentrations.

4.5.7 Acids. Assuming that locations where acids were disposed of have unsaturated zones of moderate thickness (at least 30-40 feet) small volumes of acid disposal will not exhibit strong ground water contamination potential. Due to the arid environment and probable buildup of salts in the near surface soils, acids percolating downward in the soil column will be neutralized relatively quickly unless large volumes were disposed of. As stated previously, if acidic solutions containing metals were disposed of, enhanced metal transport will occur. Acid disposal will cause some dissolution of unsaturated zone minerals and salts but for the most part this increase in total dissolved solids will be basic elements such as aluminum, and silica and will not significantly affect the already poor ground water quality.

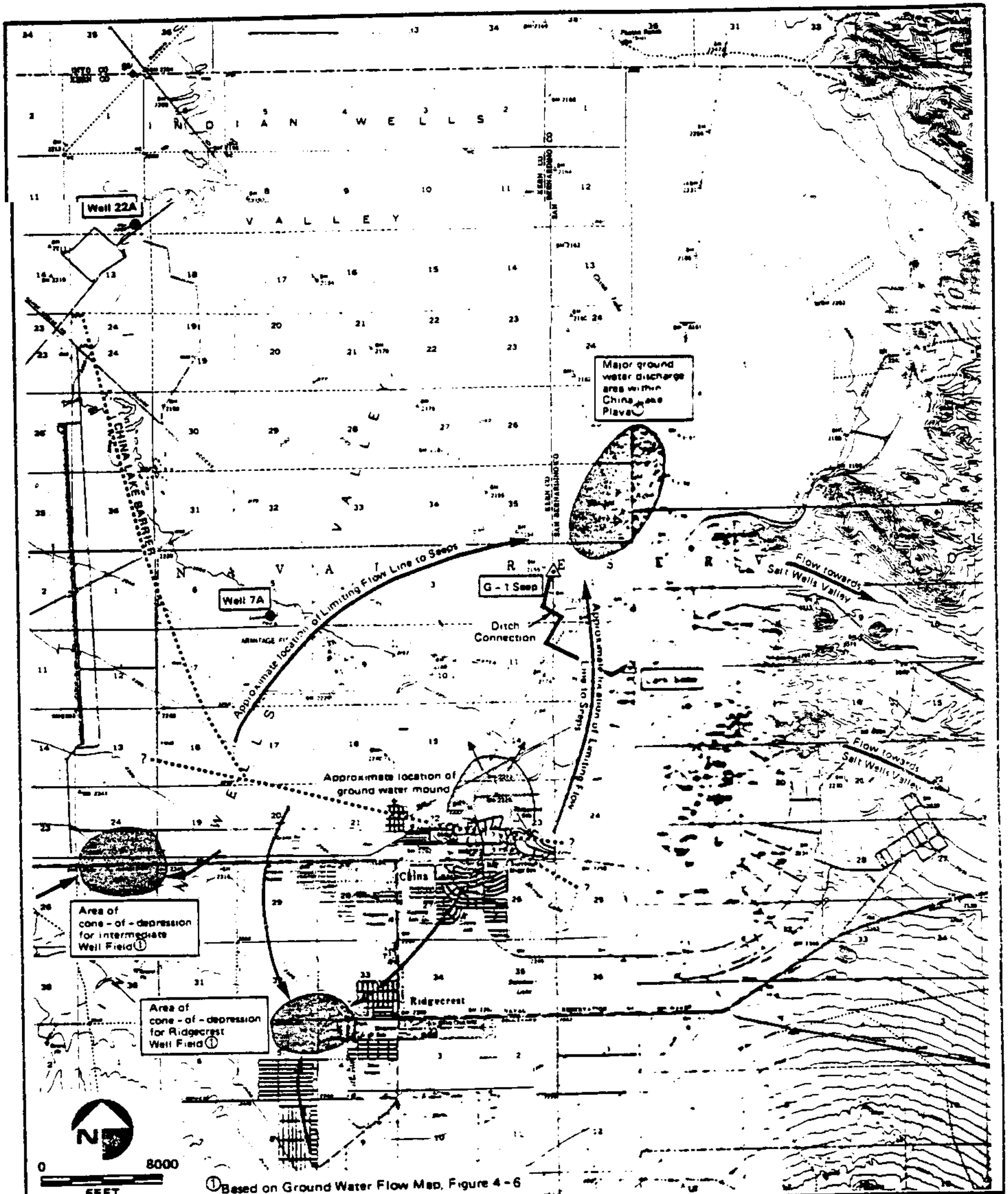
4.6 CONTAMINATION MIGRATION POTENTIAL. To summarize the potential of contaminant migration, the receptors and pathways will be described. The contaminants' persistency, solubility, and attenuation were discussed in general in Section 4.5. As there is no data on dispersion, it will be assumed that the contaminant will disperse about three degrees around the idealized flow path.

Figure 4-10 shows the generalized flow patterns and receptors. The major receptors are the seeps containing the Mohave chub which is an endangered species. These are the G-1 and Lark seeps along with the connecting drainage ditch. The other receptors are the Ridgecrest and Intermediate Well fields, and isolated Wells 7A and 22A which can be used for irrigation and domestic purposes.

In order to determine the sources of potential contamination to the seep area, limiting flow lines were constructed as shown on Figure 4-10. This illustrates that ground water flowing between these flow lines and north of the barrier in both the shallow and deep aquifers will migrate towards the seeps and their connecting drainage ditch. Contaminants in the ground water within this area have a potential to migrate to the seeps. Ground water outside these flow paths will enter the China Lake Playa but should not enter the seep area. It should be remembered that flow patterns can change and, therefore, these idealized flow paths can also change. These changes can either increase or decrease the area of flow towards the seeps.

In addition to ground water flow toward the China Lake Playa and to the seeps, another key ground water flow direction in the deep aquifer is toward the well fields south of the barrier. There is no shallow aquifer south of the barrier. The well fields produce water for public consumption and are, therefore, important receptors. Ground water south of the barrier will flow towards these wells. Therefore, any source of contamination in this area may affect the well fields. These migration paths are shown on Figure 4-10.

As discussed in the hydrogeology section, ground water flow in the shallow aquifer just north of the barrier has the potential to change directions and flow towards the south. This is due to artificial recharge from irrigation, leaky sewers, and the wastewater ponds. Thus, there is a potential for the naturally poor quality shallow ground water to flow to the Ridgecrest well field. Also, there are sites in this area containing contaminants. Therefore, this change in flow regime also can cause the contaminants to flow towards the well fields.



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Migration Pathways and Receptors

FIGURE 4-10

As shown on the figure, ground water also flows toward Salt Wells Valley. There are no known receptors in this area that will be affected by contaminated ground water.

Presently, there is not enough data available to determine the travel time for a contaminant to reach one of the receptors. The travel time is affected by the hydraulic conductivity, porosity, organic and clay content of the aquifer material and unsaturated zone material, the gradient of the water table, and the properties of the constituents as discussed previously. A general range of ground water velocities has been computed and discussed in the hydrogeology section, 4.4.4.

CHAPTER 5. WASTE GENERATION

This chapter describes past industrial, ordnance and radiological operations that have generated hazardous wastes at Naval Weapons Center (NAVWPNCEN) China Lake. The purpose of this description is to provide an historical perspective with regard to the generation and use of hazardous waste compounds at NAVWPNCEN. The chapter also serves to define waste volumes and locations of disposal.

5.1 INDUSTRIAL OPERATIONS.

5.1.1 Liquid Chemical Waste Generation. Industrial operations that generated liquid waste at NAVWPNCEN can be divided into six areas:

- Administration and Public Works Area
- Michelson Laboratory
- Armitage Field
- Range Areas
- Salt Wells Propulsion Laboratory (SWPL)
- China Lake Propulsion Laboratory (CLPL)

5.1.1.1 Administration and Public Works Area. This area contains administration buildings, former civilian dormitories, former barracks, community facilities, and the public works compound. Public works contains engineering and construction functions as well as metal and maintenance shops. Table 5-1 shows the source, type and amount of industrial and chemical waste that was generated in this area during past years. In summary, a total of 16,600 gallons a day of industrial wastes were discharged to the sanitary sewer in the administration and public works area prior to 1980. Of this amount, approximately 10,000 gallons per day (gpd) was boiler blowdown water contaminated with phosphates, sulfites, and tannins. Detergents, oil, solvents, grease, acids and caustics made up the remaining amount (approximately 6700 gpd). From the mid 1940s through 1980, most of these industrial wastes were discharged to the sanitary sewage system. Since 1980, the industrial wastewater generated in this area has been directed to a new industrial sewer which leads to two lined evaporation ponds.

5.1.1.2 Michelson Laboratory Area. Michelson Laboratory was constructed in 1947. It is the major laboratory at NAVWPNCEN China Lake containing the following departments: Systems, Fuze and Sensors, Technical Information (photographics), Engineering (machine shops), and Research and Weapons. Additionally, activities such as circuit board processing, electroplating and metal cleaning take place at the lab. From 1947 to 1980 an industrial waste collection system carried liquid waste water from these activities to two unlined ditches. Tables 5-2 and 5-3 show the inventory of industrial liquid wastes that were discharged to the two open unlined ditches prior to 1980. Approximately 9400 gallons per day of industrial wastes were discharged into the east ditch and 62,000 gallons per day of industrial wastes were discharged into the west ditch. Most of the wastes from the west drain were from electroplating or photographic operations, while the east drain was mostly cooling water contaminated with acids and algicides.

Table 5-1

Industrial Wastewater Generated at the Administration/Public Works Area

Building Number	Activity Generating Waste	Type of Waste	Estimated Maximum Daily Flow (GPD)	Point of Disposal Prior to 1980
00979	Descaling Tank and Washdown - Pipe Shop	Sulfuric Acid, Kerosene, Chemtoul B-12	100	Sanitary sewer
00978	Steam Cleaning Rack	Grease, Oil, Trichloroethylene, Carbon Tetrachloride	100	Holding Tank
00993	Paint Spray Booth Water Wall Tank	Paint Chips and Sludges	400	Sanitary Sewer
01198	Dip Tank, Solvent Tank and Washdown - Machine Shop	Caustics, Trichloroethylene, Perchloroethylene, Oil and Grease	200	Sanitary Sewer
00991	Etching Tank, Degreasing Tank and Washdown - Metal	Trichloroethylene, Sulfuric Acid, Nitric Acid, Hydrochloric Acid, Acetone, Trapropanol	500	Sanitary Sewer
00989	Waste Battery Acid and Washdown - Battery Shop	Sulfuric Acid, Nitric Acid	100	Sanitary Sewer
00989	Caustic Tank, Acid Tank and Washdown - Radiator Shop	Sulfuric Acid, Caustics and Wash Water	1,300	Sanitary Sewer/ Storm Drain
01197	Vehicle Washdown Area	Detergents, Oil and Grease	1,000	Sanitary Sewer
01343	Steam Cleaning Racks	Detergents, Oil Grease and TCE	3,000	Sanitary Sewer
01016	Boiler Plant No. 2 Blowdown Water and Softener Backwash	Phosphates, Sodium Sulfite and Tannins	5,000	Sanitary Sewer/ Storm Drain
00032	Boiler Plant No. 1 Blowdown Waste	Phosphates, Sodium Sulfite and Tannins	5,000	Sanitary Sewer
00878	Vehicle Wash Area at Fire Stations; Drill fires for training and tests	Detergents, Oil, Grease; Unburned contaminated fuel (JP-4, JP-5, AVGAS)	1,000 300	Open Drainage Ditch
Total			18,000	

Source: Lowry and Associates, (1978) Volume I.

Table 5-2

Wastewater Generated at Michelson Lab and Discharged to the West Industrial Drain Prior to 1980

Point of Generation	Estimated Maximum Daily Flow (GPD)	Composition
Laboratory Area, West Side Main Corridor	2,000	Cooling Water
	500	Discharge from Chemical Sinks, Including Dilute Acids, Bases and Solvents
Circuit Board Processing Shop (Building 0005)	10,000	Dilute Stripper, Solder Brite, Trichlorethylene
Electroplating Circuits (Building 00005)	10,000	Dilute Copper Sulfate, Metal Wastes and Acids
Metal Cleaning Facility (Building 00005)	7,000	Rinse Water, Including Dilute Chromic Acids, Caustics and Degreasers (Trichloroethylene)
Electroplating Shop (Building 00005)	20,000	Rinse Water, Dilute Cyanide, Hydrochloric and Sulfuric Acids, Sodium Chromate, Sodium Hydroxide, Nickel Acetate, Caustics, Trichloroethylene, Chromic Acid
Solid State Laboratory (Building 0332) Micro-Electronics	500	Dilute Hydrofluoric and Hydrochloric Acids, Alcohols and Solvents
	3,000	Cooling Water
	500	Deionized Water
Photo Shop South Side, Wing 1 Black & White stills (Building 00005)	5,000	Photo Processing Chemicals
Photo Shop, North Side, Wing 1 Color & Motion Pictures (Building 00005)	3,500	Photo Processing Chemicals
Total	62,000	

Source: Lowry and Associates, 1978.

Table 5-3

Inventory of Wastewater Generated at Michelson Lab and Discharged to the East Industrial Drain Prior to 1980

Point of Generation	Estimated Maximum Daily Flow (GPD)	Composition
Battery Room, Wing 6 (Building 00005)	100	Dilute Sulfuric Acid Dilute Stripper, Solder Brite,
Circuit Board Processing	4,000	Trichloroethylene
Laboratory Area, North Side Wing 6 (Building 00005)	1,000	Cooling Water
	100	Discharge from Chemical Sinks to Include Dilute Acids, Bases and Solvents
Laboratory Area, South Side, Wing 6 (Building 0005)	1,000	Cooling Water
	100	Discharge from Chemical Sinks to Include Dilute Acids, Bases and Solvents
Laboratory Area, West Side Main Corridor (Building 00005)	1,000	Cooling Water
	100	Discharge from Chemical Sinks to Include Dilute Acids, Bases and Solvents
Cooling Towers on Top of Shop Building (Building 00005)	2,000	Algicides and Scale Inhibitors
Total	9,400	

Source: Lowry and Associates, 1978.

The operations normally carried on in the electroplating shop are as follows:

Anodizing - Both clear and color coats, oxide coating of steel, stainless steel, copper and brass.

Copper plating from cyanide solution.

Silver plating from cyanide solution.

Gold plating from cyanide solution.

Nickel plating - bright and conventional.

Nickel plating - electroless.

Tin plating from an alkaline stannate solution.

Chrome plating - decorative and hard chrome from chromic acid solution.

Degreasing using trichloroethylene.

Bright dipping using chromic acid and dichromate solutions.

Descaling.

Passivating.

Associated with the wet operations are alkaline cleaning tanks, acid dips using sulfuric, hydrochloric and nitric acids, and a number of cold and hot water rinses.

The plating solutions were normally never discarded although it is conceivable that under some circumstances it may have been necessary to dispose of a tank. Under normal operating procedure the tanks were replenished with water, metal salts and additives to maintain their efficiency. Losses were normally due to dragout, i.e., the solution that was carried out of a process tank by the work being plated or treated. Water was also lost by evaporation and the water losses were made up from a deionized water system.

The alkaline cleaner solutions and the acid dip and acid strip tanks were dumped and made up fresh with varying frequencies. The acid strip and descaling tanks contained high concentrations of heavy metals and were handled in the same manner as any plating or anodizing solutions.

The main sources of waste water discharged from the plating room were the 10 rinse tanks and the condenser in the degreaser. The minimum operating flow of the plating room during working hours was about 30 gpm with a maximum flow approaching 50 gpm. All of this water was discharged to the industrial waste drain and contained heavy metals originating in the plating and anodizing solutions. The discharge from the electroplating shop was one of the major sources of industrial wastewater from the Michelson Laboratory.

Trichloroethylene was used in the degreaser and occasionally the degreaser was desludged. The sludge was disposed of as a solid waste. Any trichloroethylene disposed of was placed in drums for separate disposal. It is likely that this waste was hauled off to the Pilot Plant Road Landfill or SNORT Landfill sites.

The following is a list of the electroplating shop chemicals used and the approximate consumption per year:

Trichloroethylene	1800 gallons
Acetone	70 gallons
Hydrochloric Acid (20°-22° Be)	60 gallons
Sulfuric Acid (66° Be)	200 gallons
Nitric Acid (Concentrated)	330 gallons
Sodium Hydroxide	100 gallons
Sodium Hydroxide (Approximately 50%)	30 gallons
Chromic Acid	200 pounds
Chromic Acid (Etching Solution)	500-100 gallons
Boric Acid	50 pounds
Acidic Acid (Concentration)	3 gallons
Ammonia Hydroxide (Concentration)	50 gallons
Vapor Degreasing Solvent-Freon	300 gallons
Turco Solvent	30 gallons
Potassium Hydroxide	75 pounds
Ferric Chloride (Etchant)	Up to 1000 gallons
Copper Cyanide	75 gallons
Silver Cyanide	50 gallons
Cadmium Oxide	None Used in 1977
Sodium Cyanide	100 pounds
Potassium Cyanide	75 pounds
Nickel Sulfate	200 pounds
Nickel Sulfamate (Solution)	5 gallons
Nickel Acetate	200 pounds
Fluoboric Acid (48%)	30 gallons
Ethyl Alcohol - 190 Proof	500-1000 gallons
Ethyl Alcohol - Reagent Grade	20-25 gallons
Copper Pyrophosphate (Solution)	200 gallons
Black Oxide Coating for Steel (Alkaline Materials)	200 pounds
Black Oxide Coating for Stainless (Alkaline Materials)	10 pounds
Black Oxide Coating for Copper and Brass (Alkali)	10 pounds
Potassium Stannate	100 pounds
Alodine Solution Containing Ferricyanide Salts, Acidic Chromate and Fluorides	100 pounds
Dyes for Color Coating	100 pounds

Source: Lowry and Associates, 1978.

Included in the list of materials are the materials used in the printed circuit processing and plating shops. This is a very small shop but the printed circuit etching operations are one of the major sources of chromic acid at the laboratory. Prior to 1980 this material was discharged to the industrial waste drains. The amount of hexavalent chromium used and disposed of in the printed circuit processing appears to be as much as ten times that used in the larger electroplating shop. The waste solution contains other heavy metals as well. The small printed circuit plating shop is a very intermittent operation. The operations are similar to the large shop and include electroless copper plating, acid copper pyrophosphate, nickel, tin-lead and rhodium plating. The copper pyrophosphate solution was disposed when contaminated.

Since 1980, these Michelson Lab industrial wastes have been discharged into a new industrial sewer system which leads to two lined evaporation ponds.

5.1.1.3 Armitage Field. Armitage Field (AF) supports all air operations including developmental test and evaluation (DTE) and operational test and evaluation (OTE). Included here are operations, aircraft intermediate maintenance, laboratories, storage and support facilities. Prior to 1980 wastes generated in this area either discharged to an open ditch or to the sanitary system (Imhoff Tank/Percolation Pond). After 1980, wastes were discharged into a newly constructed sanitary sewer that flows to the City of Ridgecrest's treatment plant. Petroleum wastes are collected in oil-water separators before entering the sewage lines. Industrial wastes that were generated at AF are shown in Table 5-4.

The AF sanitary system, prior to 1980 handled 17,000 gpd of wastewater, including approximately 1500-3000 gpd of wash water and boiler blowdown (Lowry and Associates, 1978; Table 5-4 does not reflect these flows as all the sources were not documented in the Lowry report). It also received 500 gpd of wastewater contaminated with detergents, solvents, grease and oil (shown on Table 5-4). This waste ultimately went to a percolation/leach pond.

Approximately 6000 gpd of detergent, solvents, grease and oils and 1000 gpd of sodium phosphate, sodium sulfite, and tannin-contaminated wastewater were discharged to the open drainage ditch or the storm sewer which utimately reached the open drainage ditch. These flows are further described in Table 5-4.

Waste fuel (contaminated JP-4 and JP-5) was also generated in the AF area. Approximately 1 million gallons of this waste fuel were generated between the years of 1945-1982. This waste fuel was ultimately disposed of in dry wells at the fuel farm (Leedshill-Herkenhoff, 1982).

5.1.1.4 Range Areas. NAVWPNCEN China Lake contains a number of Range areas classified into broad categories as follows: Air Ranges; High Speed Track Complex; Ground Ranges; Warhead Test Facilities; Area R Test Complex; Burro Canyon Test Complex; Thompson Laboratory; Environmental, Safety and Non-Destructive Test Facilities; Fuel Air Explosive Test Complex; Propulsion Test Range; Special Purpose Ranges; and Randsburg Wash.

Each range has a specific purpose and consequently is operated accordingly. Many of the ranges overlap physically hence, coordination in these operations is necessary. Only a few of these ranges have generated industrial wastes. These ranges have been identified as ER, G-1, G-2 and R (Lowry and Associates, 1978).

Table 5-4

Industrial Wastes Generated at Armitage Field

Building Number	Activity Generating Waste	Type of Waste	Estimated Maximum Daily Flow (GPD)	Point of Disposal Prior to 1980
—	Aircraft Wash Area South of Hanger No. 3	Detergent, Trichloroethylene, Grease, and Oil Contaminated Wastewater	4,500	Open Drainage Ditch
20000	Shop Areas in Hanger No. 3 Discharging to Floor Drains	Grease, Oil, and TCE Contaminated Wastewater	1,000	Open Drainage Ditch
20011	Wash Area in Shop	Solvents, Detergent, Grease, and Oil Contaminated Wastewater	500	Sanitary Sewer (Percolation Pond)
02186	Steam Cleaning Area at Ground Support Area	Detergent, TCE, Grease and Oil Contaminated Wastewater	500	Open Drainage Ditch
20007	Boiler Plant No. 3 Blowdown	Phosphates, Sodium Sulfite, and Tannins Contaminated Wastewater	1,000	Storm Drain
Fuel Farm	Contaminated Jet Fuel	JP-4 and JP-5	100	Dry Wells at Fuel Farm

Source: Lowry and Associates, 1978.

All of the above mentioned range areas generating sanitary and industrial wastes used septic and leach field systems or cesspools prior to 1980. Due to a high water table and/or poor percolation characteristics of the soil at many of the range sites, some of the leach fields did not function correctly. This failure of leach fields has resulted in septic tank effluent surfacing near some range structures.

Several types of industrial wastes were generated within the range areas, including chemicals such as photo film developer, fixing solutions, algicides, laboratory wastes and cooling tower blowdown. Table 5-5 lists the sanitary and industrial wastes generated by the range areas. Most of the effluent in these areas was from cooling tower water. A total of 47,300 gpd of effluent was generated in these various range areas prior to 1980. Much of the industrial wastes generated consisted of cooling tower blowdown (20,200 gpd). Approximately 100 gpd of solvents, etching wastes, photo lab wastes and paint sludge were generated in these areas. The remaining wastes (27,000 gpd) were sanitary wastes. In 1980 these ranges were tied to the sanitary sewer system so that septic tanks and leach fields are no longer used.

5.1.1.5 Salt Wells Propulsion Laboratory (SWPL) and China Lake Propulsion Laboratory (CLPL). Industrial wastewaters containing chemicals that were used to test explosives were discharged to settling basins at CLPL and SWPL prior to 1980. Effluent from the settling basins flowed to unlined ditches. Once in the ditches, the wastewater evaporated or percolated into the soil. Industrial wastes other than explosive waste were discharged directly to unlined ditches. In addition, chemical-contaminated wastewaters were also discharged to the septic tank and leach field system at SWPL and CLPL.

Chemicals discharged at the SWPL include photo developer and fixing solutions, waste solvents (trichloroethylene), sulfuric acids, boiler blowdown and miscellaneous chemical wastes. Table 5-6 lists the locations, amounts and types of industrial wastes generated at SWPL. The combined flow from SWPL was 14,150 gpd. From 1946 to 1981, China Lake Propulsion Laboratory area discharged wastewater containing RDX (cyclotrimethylene trinitramine) materials and AP (apache coal powder) to unlined ponds from Buildings 10570 and 10580. The volume of RDX and AP wastes is not known. In addition, there were three leach fields that received similar wastewater contaminated with phosphates, sodium sulfides, dilute TNT, RDX and AP explosives, trichloroethylene (TCE), oil, grease and photo lab chemicals. The three leach fields were near the CLPL administration area (Building 105), near the CLPL experimental line (Building 304), and at the CLPL static firing area. They had a combined flow of about 7500 gpd.

5.1.2 <u>Solid Waste Generation</u>. The types of solid wastes may be categorized by the generation area as follows: Family housing wastes; Base facilities wastes; Shop and industrial wastes.

Family housing wastes were generated at the rate of approximately 8858 tons per year during past operations. These wastes included all dry trash, lawn and garden wastes, and garbage generated at the family housing complexes. Other base facilities (excluding industrial shops) generated solid wastes at the rate of approximately 4357 tons per year. These wastes included street sweepings and

Table 5-5

Sanitary and Industrial Wastewater Generated at Range Areas ER, R, G1, G2

Range Area	Point of Generation	Type of Waste	Estimated Maximum Daily Flow (GPD)	Point of Disposal Prior to 1980
ER	Thompson Laboratory Buildings 31433 and 31439	Sanitary Wastes	8,000	Septic Tank/Leach Field
ER	Thompson Laboratory Building 31433	Cooling Tower	14,400	Open Drainage Ditch
ER	Anti-Radiation Laboratory Buildings 31434 and 31440	Sanitary Wastes	3,300	Septic Tank/Leach Field
ER	Building 31434	Etching Wastes	Negligible (1)	Septic Tank
R	R Range Complex (All Buildings)	Sanitary Wastes	9,400	Septic Tank/Leach Field
R	Building 31504	Dilute Solvents	Negligible (1)	Septic Tank/Leach Field
R	Warhead Development Building 31600	Photo Lab Wastes	Negligible (1)	Cesspool
R	Earth and Planetary Science Building 31598	Cooling Tower	5,800	Open Drainage Ditch
R	Earth and Planetary Science Building 31598	Dilute Solvents	100	Leach Field
G1	G1 Range Complex	Sanitary Waste	1,800	Septic Tank/Leach Field
G1	Telemetering Building Building 30881	Photo Lab Wastes	Negligible (1)	Septic Tank/Leach Field
G2	G2 Range Complex	Sanitary Wastes	4,500	Septic Tank/Leach Field
G2	Building 30954	Paint Sludge	(2)	Open Drainage Ditch

(1) Less than 30 gallons per day
(2) 400 gallons per year

Source: Lowry and Associates, 1978.

Table 5-6

Industrial Wastewater Generated at the Salt Wells Propulsion Laboratories

Building Number	Activity Generating Waste	Type of Waste	Estimated Maximum Daily Flow (GPD)	Past Point of Disposal Prior to 1980
11580	Machine Shop Degreasing Tanks	Trichloroethylene (TCE), Grease, Oil	(1)	Open Ditch
14530	Blowdown and Cooling Water from Boiler No. 4	Phosphates, Sodium Sulfites, Tannins	5,000	Open Drainage Ditch
15950/15956	Wash Water From Explosives Cleaning Area	Dilute Explosives (RDX, AP, TNT) and Solvents	500	Open Drainage Ditch
15956	Propellant Cleaning Tank	TCE and RDX, AP Explosives	(1)	Open Drainage Ditch
15980	Wash Water From Explosives	RDX and AP Explosives Cleaning Solvents (TCE)	500	Open Drainage Ditch
15741, 15742 15743, 15744	Wash Water From Explosives Settling Tank	Dilute RDX, AP Explosives	1,000	Open Drainage Ditch
15790	Photo Developing and Fixing Solution	Dilute Photo Chemicals	(1)	Open Drainage Ditch
15810	Wash Water From Explosives Cleaning	Dilute Explosives	500	Open Drainage Ditch
15700	Wash Water from Explosives Settling Tank	Dilute Solvents (TCE) and Explosives	2,000	Open Drainage Ditch
15730	Cooling Water	Increased TDS	2,000	Open Drainage Ditch
15730	Wash Water from Flock Drains	Dilute Propellants, Ammonia	50	Open Drainage Ditch
15510, 15521 15522, 15523 15524, 15560	Wash Water from Explosives Settling Tank	Dilute Explosives and Solvents (TCE)	2,000	Open Drainage Ditch
15590	Wash Water from Explosives Settling Tank	Dilute Explosives and Solvents (TCE)	100	Open Drainage Ditch
15530	Hydraulic Press	Chemically Unchanged	500	Open Drainage Ditch
Total			14,150	

(1) Less than 10 gallons per day

Source: Lowry and Associates, 1978.

storm sewer catch basin cleanings; hospital wastes; incinerator residues; classified wastes; tree trimmings and park wastes; dining facilities wastes; demolition wastes; garbage; and sanitary sludges. Shop and industrial wastes were generated at the rate of approximately 2080 tons per year. These wastes included ferrous and non-ferrous metal scraps; batteries; aircraft scrap parts; computer tab cards; and a variety of hazardous chemical elements and compounds.

The hazardous chemical elements and compounds in solid form that were generated are detailed in a 1977 industrial survey (NAVWPNCEN, 1977). The survey shows about 1025 pounds/year (sodium hydroxide and explosive powders) generated by the Laboratory Directorate; 1000 pounds/year of 10 chemicals generated by the Laboratory Directorate, Engineering Department; 18 pounds/year of about 50 chemicals from the Laboratory Directorate, Engineering Department, Engineering Services Division; 7300 pounds/year of metal wastes from the Laboratory Directorate, Weapons Department; 150 pounds/year generated by the Test and Evaluation Directorate, Aircraft Department; and 130 tons/year of explosives, and 163 pounds/year of sodium sulfate from the Test and Evaluation Directorate, Range Department.

In summary, approximately 15,295 tons of solid wastes of all categories to include hazardous as well as non-hazardous have been generated annually at the NAVWPNCEN.

5.2 ORDNANCE OPERATIONS. Operations involving the research, development, testing, and evaluation (RDTE) of weapons and ammunition at the Naval Weapons Center (NAVWPNCEN) evolved immediately following the establishment of the NAVWPNCEN in 1943. Initially, the NAVWPNCEN provided testing areas for ordnance materials and systems while operating a propellant pilot plant. In 1945, the NAVWPNCEN embarked upon rocket development work and launched a continuing program in the RDTE of ordnance-related material. Since 1945, the combination of all ordnance operations conducted--over the years--by the various NAVWPNCEN organizations has resulted in a generation of ordnance waste.

Ordnance waste as discussed in this section and Sections 6.2 and 7.2 of this report primarily relates to all explosives, pyrotechnics and propellants as well as those munitions and devices in which these materials may be encased.

Disposal sites used for ordnance operations include the Beryllium contaminated Equipment Site, T-range, B-Mountain, Burro Canyon, and CT-4 Disposal Sites. Beryllium related tests were short-lived and were discontinued in the mid-1960s. In addition, liquid discharges to open drainage or ponds occurred at the Michelson Laboratory, China Lake Propulsion Laboratory, and Salt Wells Propulsion Laboratory. It should be noted that several range areas are off limits due to past ordnance contamination (i.e. unexploded bombs, etc.).

5.2.1 Laboratory Testing and Manufacturing. The NAVWPNCEN testing and noncommercial production of ordnance constituents began in the early days of the Center when the principal function of the China Lake Pilot Plant was the pilot production of propellant grains. Chemical research as early as 1943 led to the development and manufacture of improved propellants, explosives, and pyrotechnics (PEP). Waste generators that synthesized elements and compounds for the noncommercial manufacture of PEP materials were the China Lake Propulsion Lab, Salt Wells Propulsion Lab, and Michelson Laboratories. Some chemicals and combination of chemicals associated with ordnance material development and generated as wastes by the three laboratory operations appear in the following list.

Hydrazine
Selenium
Sodium Thiocynate
Bromine
Sodium Chlorate
Sodium Bromate
Sodium Peroxide
Ammonium Perchlorate
Antimony Trioxide
Arsenic Trioxide
Methanol
Trichloroethylene
Toluene
Butanone
Perchloroethylene
Isopropanol
Xylene
Iron Pentacarbonyl
Allyl Glycidyl Ether
Kersosene
Ethanol
Carbon Tetrachloride
Petroleum Destillate
Chloroform

Acids:
- Hydrochloric
- Nitric
- Sulfuric
- Chromic
- Floroboric
- Carbolic
- Oxalic
- Hydriodic
- Hydrobromic
- Hydrofluoric
- Perchloric
- Phosphoric

Cyanides:
- Sodium
- Potassium
- Silver
- Copper

Fluorides:
- Potassium
- Ammonium
- Sodium

Hydroxides:
- Sodium
- Ammonium
- Potassium

Chlorides:
- Ferric
- Barium
- Cadmium
- Mercuric
- Zinc

Oxides:
- Cadium
- Lead
- Mercuric

Bifluoride:
- Potassium
- Dichromate
- Potassium

Acetates:
- Butyl
- Nickel
- Lead
- Ethyl

Sulfates:
- Nickel
- Cadium
- Ammonium

Nitrates:
- Ammonium
- Calcium
- Copper
- Lead
- Potassium
- Silver
- Sodium

Average quantity of these ordnance chemical wastes generated by the three laboratories since 1945 is estimated to be between 29,000 and 42,000 pounds a year.

5.2.2 Ordnance Testing. Testing of ordnance also produces solid wastes requiring disposal. The current quantity of wastes generated by ordnance RDTE efforts is estimated at 56,000 pounds a year. Earlier years of wastes generated are believed to have been similar in both quantity and type. The type and quantities generated in the ordnance waste categories appearing in the following table are:

Ordnance Testing Waste	Estimated Average Annual Volumes (lbs)
1. Propellants, explosives, and pyrotechnic (PEP) mixtures	17,000
2. Flares, arming devices, and fuzes	500
3. Blasting caps, igniters, electric squibs, and detonating cord	300
4. Small arm and cannon ammunition, gun projectiles, and catapult devices	400
5. Rocket and missile warheads and mortars	12,300
6. Bomblets, bombs, and bomb components	14,700
7. Mines and other miscellaneous ordnance	10,800

5.2.3 Demilitarization: Steam Out, Wash Out, Drill Out. Demilitarization of ordnance material is the responsibility of trained Explosive Ordnance Disposal (EOD) unit personnel. In demilitarization operations involving steam out, wash out, and decontamination, residual washwaters and residues from incomplete decontamination result in waste generation. Demilitarization has been a prerequisite for the resale of residual ordnance material resulting from ordnance testing operations. Waste from such operations are principally generated at the point of demilitarization. Demilitarization has been conducted at Burro Canyon and at the CT Ranges located near the Salt Wells Propulsion Laboratory. The volume of demilitarized waste is not known. On rare occasions the EOD unit has referred ordnance ammunition for demilitarization to the Army Ammunition Plan in Hawthorn, Nevada. However, safety constraints on the shipment of ammunition have resulted in a very limited program of shipping ordnance for demilitarization.

5.3 RADIOLOGICAL OPERATIONS. No radioisotopes other than sealed sources (radium dials) or depleted uranium existed between 1945 and the present at NAVWPNCEN China Lake. Additionally, some industrial x-ray sources also were onsite. Consequently, no radioisotopes other than depleted uranium were disposed of at NAVWPNCEN China Lake. Depleted uranium (DU) is processed uranium with U 235 isotope removed. The resultant is a processed uranium slightly above natural background levels but below the radioactivity of processed uranium (fuel). It also contains trace amounts of a radioactive daughter product, thorium. The DU was handled in Buildings 570, 551, 168, 168 A and 309. After testing the DU levels, the propellant DU material was disposed of by burning. Burning took place at T-range burning ground in pits 1 and 2. A total of approximately 250 pounds of powdered DU/thorium mixture was disposed of by burning at this site on 10 different occasions between 1962 and 1967. Also, in a manner similar to live ordnance contamination on the ranges, depleted uranium projectiles contaminate some range areas.

CHAPTER 6. MATERIALS HANDLING: STORAGE AND TRANSPORTATION

This chapter describes past waste storage and transportation operations and facilities at Naval Weapons Center (NAVWPNCEN) China Lake.

6.1 INDUSTRIAL OPERATIONS.

6.1.1 Solid Wastes. General solid waste has historically been and continues to be collected and disposed of by a private contractor under a Public Works administered contract.

6.1.1.1 Refuse and Garbage. Refuse and garbage are placed in various sizes of storage containers outside buildings and collected by a private contractor for disposal in the Ridgecrest sanitary landfill. Prior to 1980 the contractor hauled much of this waste to several disposal sites on the NAVWPNCEN. After 1961 the contractor also operated and maintained these disposal sites. The sites received mostly Group 2 and 3 wastes. Chapter 8 provides a description of these waste types for each site.

Five hundred sixty-eight 3-cubic yard containers are located throughout the administration and housing area of NAVWPNCEN China Lake. Additionally 21 three-cubic yard containers are required for wet wastes. Thirty-six 6-cubic yard containers are required for dry materials and there are approximately 832 thirty-gallon garbage cans in use. Collection is twice weekly resulting in an annual collection of over 13,000 tons of refuse and garbage hauled by a private contractor.

6.1.1.2 Industrial Wastes. Prior to 1980, solid industrial wastes were transported to various solid waste disposal sites throughout NAVWPNCEN China Lake (discussed in Chapter 8). Temporary storage areas were established at the CT-4 and Baker Range disposal sites for recoverable aluminum and steel. The Defense Property Disposal Office (DPDO) intermittently picked up these recoverables and stored them in the DPDO yard prior to sale. Since 1980, these sites have been closed and salvagable material is transported directly to the DPDO area.

6.1.2 Chemical and Hazardous Waste. Since 1978, hazardous wastes have been segregated and stored at the Hazardous Waste Transfer Facility on the NAVWPNCEN and are subsequently disposed of by contract at a licensed offsite disposal facility. Table 6-1 shows the annual amount of these wastes stored recently (1983) at NAVWPNCEN China Lake which provides some perspective for past generation rates. Chapter 5 provides a complete description of the waste types, amounts and locations generated by NAVWPNCEN China Lake's past operations.

Prior to 1978 no attempt was made to segregate and store chemical or hazardous wastes at the generation point for a separate collection. Chemical wastes were placed into dumpsters along with miscellaneous Group 3 solid wastes. These containers were transported by contractor to solid waste disposal sites on the NAVWPNCEN. Transportation and disposal of these chemical wastes occurred in this manner between the mid 1940s to 1980.

Table 6-1

Recent (1983) Storage of Hazardous Wastes

Description of Wastes	Annual Amount of Wastes Stored (gallons)
Acids spent from plating operations	14,750
Oily Wastes	2,000
Spent cyanide plating solutions	300
Laboratory wastes, miscellaneous chemicals	6,000

6.1.3 Storage Tanks. At present count there are 53 underground storage tanks at NAVWPNCEN China Lake. Table 6-2 describes the tanks with the tank size, number, and the types of fuel stored. There is no evidence of leakage at any of the tanks. Currently, there are 13 storage tanks for #6 oil used to fuel boilers at NAVWPNCEN China Lake. Additionally, aircraft fuel for the Armitage Field facility is stored in six underground tanks located at the eastern side of the airfield complex. Four of these tanks have a capacity of 50,000 gallons, two are 110,000 gallons in size. A number of underground storage tanks also exist for motor vehicle fuel.

Table 6-2

Underground Storage Tanks at NAVWPNCEN China Lake

Location	Size (gallons)	Number	Fuel Stored
Boiler plants	100,000-120,000	3	#6 fuel oil
	10,000-26,000	10	#6 fuel oil
NAF fuel farm	110,000	2	JP-4 and JP-5
	50,000	4	JP-4 and JP-5
Gas stations or loading racks	1,000-25,000	20	Regular, unleaded and diesel gasoline
Other	300-15,000	14	Diesel, Avgas JP-5
Total		53	

6.1.4 <u>Scrapyard and Salvage Operations</u>

6.1.4.1 Industrial Scrap. The Defense Property Disposal Office (DPDO) attached to NAVWPNCEN China Lake has been and is responsible for the disposal of recyclable or usable scrap materials. Bulk scrap materials are accumulated in the DPDO yard behind Building 01073 on Iwo Jima Road until there is a large enough quantity for sale. From 1945 until 1970, the DPDO yard was located slightly east of its present location on Iwo Jima Road (see chapter 8, Site 28).

The decision whether materials are to be declared excess and delivered to DPDO or whether they are considered waste materials which are disposed of by the refuse and garbage hauling contract is a decision made by the operating facilities.

The transportation division of the Public Works Department is responsible for hauling the material to the DPDO yard from different shops on an on-call basis. Annually 2000 tons of ferrous and non-ferrous scrap and 80 tons of computer tab cards are recycled.

6.1.4.2 Salvage. The Employee Services Board (ESB) is responsible for the recyling of more common materials. Drop off points for specified recyclable materials are identified and a private contractor, collects and transports these off base for sale. The program initially started at one location and has now expanded to 75 pickup locations scattered throughout NAVWPNCEN China Lake. Paper, glass and aluminum cans are the primary recyclable materials handled. Approximately 70 tons of glass and 40 tons of newspapers are collected annually. Also, bones and fat from the NAVWPNCEN China Lake Commissary operations are picked up twice weekly for recycling. The quantity is estimated at 15 tons annually.

6.1.5 <u>Transformer Storage Yard</u>. Prior to 1980 a polychlorinated biphenyls (PCB) compliance program did not exist. Salvageable transformers were probably stored in the DPDO storage area on Iwo Jima Road discussed above. Under the current PCB compliance programs, salvageable transformers containing PCBs are stored in a fenced area behind the Public Works compound. On July of 1983 there were six transformers containing 2016 kg of PCB in this storage area. During 1980, 970 kg of PCB waste oils were sent to a Class 1 landfill in Beatty, Nevada. Additionally, 1 capacitor, containing 399 kg of PCB, was sent to Beatty for disposal.

6.2 ORDNANCE. Explosives and related ordnance materials are stored in a number of locations at NAVWPNCEN China Lake. The Ordnance Division, Code 614, is the main storage depot for the receiving and shipping of ordnance and currently has about 30 large, closed storage magazines. The Ordnance System Department, Code 32, handles the largest volume of ordnance and currently has about 126 storage magazines. These ordnance storage facilities were designed to meet or exceed military standards and were given thorough consideration to the adequacy of location, compatability groupings, proper containerization of materials, and protection from the weather elements. Ordnance storage facilities and their contents are routinely inspected and inventoried. Although the transport of extremely hazardous ordnance materials is normally accomplished by the EOD unit assigned to the Range Department, the transportation service element of the Ordnance System Department has responsibilities for the routine movement of hazardous ordnance material from building to building, and for moving ordnance residue material from the laboratories to disposal sites at the Center. The ordnance transportation element also participates with the EOD unit in decontaminating waste material from the test ranges.

6.3 RADIOLOGICAL OPERATIONS. No radioiosotopes other than sealed sources (radium dials) and depleted uranium (DU) were used at NAVWPNCEN China Lake. Some industrial x-ray testing sources existed on site also. Consequently, no radioactive contaminated material was stored or transferred at NAVWPNCEN China Lake other than residual amounts of depleted uranium transported to the range area for burnoff. Refer to Chapter 5, Section 5.3 for a more detailed discussion of the use and disposal of DU wastes.

CHAPTER 7. WASTE PROCESSING

This chapter discusses the various methods of waste processing used at Naval Weapons Center (NAVWPNCEN) China Lake. Descriptions of industrial, ordnance, and radiological waste processing are provided.

7.1 INDUSTRIAL OPERATIONS. Past industrial operations at the NAVWPNCEN involving waste processing provided for the treatment of sanitary and industrial wastes generated by the various facilities and shops discussed in Chapter 5 (Waste Generation). The Center processes a great variety of wastes produced by test facilities located in the range areas, laboratories, shops, and by propellant and explosive testing facilities. The NAVWPNCEN industrial operations involving waste processing are described below for sanitary waste treatment, industrial waste treatment, and incinerators.

7.1.1 Sanitary Waste Treatment.

7.1.1.1 Sewage Treatment Plant. The City of Ridgecrest and the NAVWPNCEN community are each served by a separate sewer system, and each system terminates at the Ridgecrest Sewage Treatment Plant. This plant, though located within the NAVWPNCEN boundary on Knox Road north of the administration area, is owned and operated by the City. Prior to the City of Ridgecrest treating City and China Lake wastewater the plant was operated and owned solely by NAVWPNCEN China Lake. The sewage treatment plant has a design capacity of 3.12 million gallons per day. It has been estimated that the sewage load from the City is 1.3 million gallons per day and the NAVWPNCEN's sewage load is 0.8 million gallons per day. Thus, a combined load of 2.1 million gallons per day is treated by the plant. The treatment process includes primary sedimentation and oxidation ponds so that secondary treatment is achieved. Discharge is to unlined evaporation ponds. Treated effluent is also used at the nearby golf course for irrigation.

7.1.1.2 Septic Tanks and Leach Fields. At some locations at the Center, sanitary wastes were discharged to leach ponds or septic tanks with leach lines. Some of these systems failed due to unsuitable conditions. This resulted in contaminated wastewater reaching the ground surface. Ranges ER, R, G-1, and G-2, China Lake Propulsion Laboratory, and Salt Wells Propulsion Laboratory were areas served by septic tanks or leach fields. Most range areas disposed of sanitary wastes by means of septic tanks and leach fields. Buildings on the ranges are widely dispersed, and each was served by a separate septic system. The high ground water and poor soil percolation rates caused the leach fields to fail. Specific leach fields that were used for hazardous waste disposal are listed in Chapter 8.

Before 1981, Armitage Field was served by a separate sewer system which went to an Imhoff tank. Effluent from the tank went to an evaporation/percolation pond east of Water Road.

In order to preclude the possibility of ground water contamination by sewage effluent, a new sewer was constructed in 1981 which connects Armitage Field and Ranges ER, R, G-1, and G-2 to the Ridgecrest Sewage Treatment Plant. Domestic wastes from the China Lake and Salt Wells Propulsion Laboratories are currently discharged into a sewer system connected to evaporation ponds located at the southeast portion of NAVWPNCEN. The sanitary sewer systems that once serviced these areas were constructed in the mid-1940s, but were rehabilitated in 1981 through the replacement of failing leach fields with deep drilled seepage pits; installation of new sewer pipes to replace deteriorated sewers and to intercept existing open discharges; and construction of two evaporation/percolation sewage ponds having a surface area of 2 acres.

7.1.2 Industrial Waste Treatment. Prior to 1981, industrial wastes were seldom treated prior to ultimate disposal at the NAVWPNCEN. Industrial wastewaters from the various facilities and shops at the Center were either discharged to open drainage channels or to the sanitary sewer. These industrial wastes contained untreated acids, caustics, solvents, oil, grease, and a variety of chemicals. They were generated at the Public Works compound and Michelson Laboratory areas (see Chapter 5 for a discussion of waste generation rates from these areas). Contaminated sludge from the sewage treatment plant was likely to have been taken to landfills on the base such as the SNORT, Pilot Plant Road, or Lauritsen Road landfills. Explosive wash waters, photo lab chemicals, laboratory and cooling system wastes were generated in the CLPL, SWPL, and Armitage Field areas and discharged directly to on-site disposal areas without treatment.

In 1981 two lined evaporation ponds (7.2 acres in size) were built to receive the liquid industrial wastes from Michelson lab and the Public Works compound. Similarly, lined evaporation ponds were built at the CLPL and SWPL for industrial wastewaters. Armitage Field and nearby range areas were connected to the main NAVWPNCEN sewer system and the Ridgecrest Sewage Treatment Plant. Also, oil-water separators were installed at Armitage field. NAVWPNCEN Instruction 6240.6 (25 February, 1982) does not allow the disposal of concentrated hazardous wastes at any location on base, including into any sewers.

7.1.3 Incinerators. The NAVWPNCEN incinerates some solid waste through use of a single chamber incinerator, an air curtain incinerator, and an open barrel incinerator. The single chamber incinerator is used only for the incineration of classified waste which cannot be shredded and mulched. This incinerator is constructed of brick and destroys approximately 1 ton of waste per year. Burning in the single chamber incinerator is accomplished on the average of once every 2 weeks.

Construction of the air curtain incinerator which is currently located near the Salt Wells Propulsion Laboratory in the T area was completed in 1978. This incinerator is used to burn propellant, explosives and pyrotechnic contaminated trash. It is used approximately once every 2 months for that purpose.

The open barrel incinerator is located adjacent to the medical clinic and is used for incinerating hazardous material such as old medications, injection needles, narcotics, and similar materials.

7.2 ORDNANCE. Past practices in the disposal of ordnance waste made extensive use of the currently abandoned practice of land spreading. Land spreading of ordnance waste was almost invariably preceded by "wetting down" or diluting the waste material prior to discharging it into open (surface) discharge areas. The discharge normally extended from the point of discharge (laboratories and propellant machining buildings) to some distance along the ground.

The evaporation disposal process, though not as extensively employed as land spreading prior to 1981, was widely used. Currently, the NAVWPNCEN utilizes 19 clay-lined evaporation ponds, located in the Salt Wells and China Lake Propulsion Laboratory areas, for handling chemical wastes and explosive wastewaters. Use of these ponds began in 1981.

Recycling of hazardous ordnance waste was almost never accomplished, although large quantities of "old scrap" steel and aluminum (non-hazardous) have been brought in from the ranges and sold through DPDO operations.

Incineration of ordnance waste material as a means of processing these wastes at the Center has been the most prevalent method practiced at the NAVWPNCEN. Since 1943, incinerated ordnance wastes have included Beryllium-based propellants (early '60s); Hexane; Hydrazene; Diborane rocket fuel; and the various hazardous constitutents used in the synthesis of propellants, explosives, and pyrotechnics. Currently, a small amount of material is burned at the B-Mountain Demolition Range. An air curtain incinerator in use is located in the T-Range Burning area near the Salt Wells Propulsion Laboratory.

7.3 RADIOLOGICAL OPERATIONS. The only processing of radiological waste at NAVWPNCEN involved the burnoff of depleted uranium (DU) which was used in ballistic weapon testing. This weapons burnoff procedure occurred on occasion from 1956 to 1958 at the CT-4 disposal site.

CHAPTER 8. DISPOSAL SITES AND POTENTIALLY CONTAMINATED AREAS

As a result of onsite surveys, personnel interviews and historic records review, the IAS team identified a total of 42 disposal sites and potential contaminated areas at NAVWPNCEN China Lake. This chapter describes the sites with regard to the physical character and location, the type and quantity of wastes and the migration pathways of the contaminants in the soil and ground water. Figures 2-1, 2-2, 2-3, and 2-4 in Chapter 2 show the locations of all disposal sites at NAVWPNCEN China Lake. Figure 8-1 shows the key sites and receptors along with general flow patterns and migration pathways.

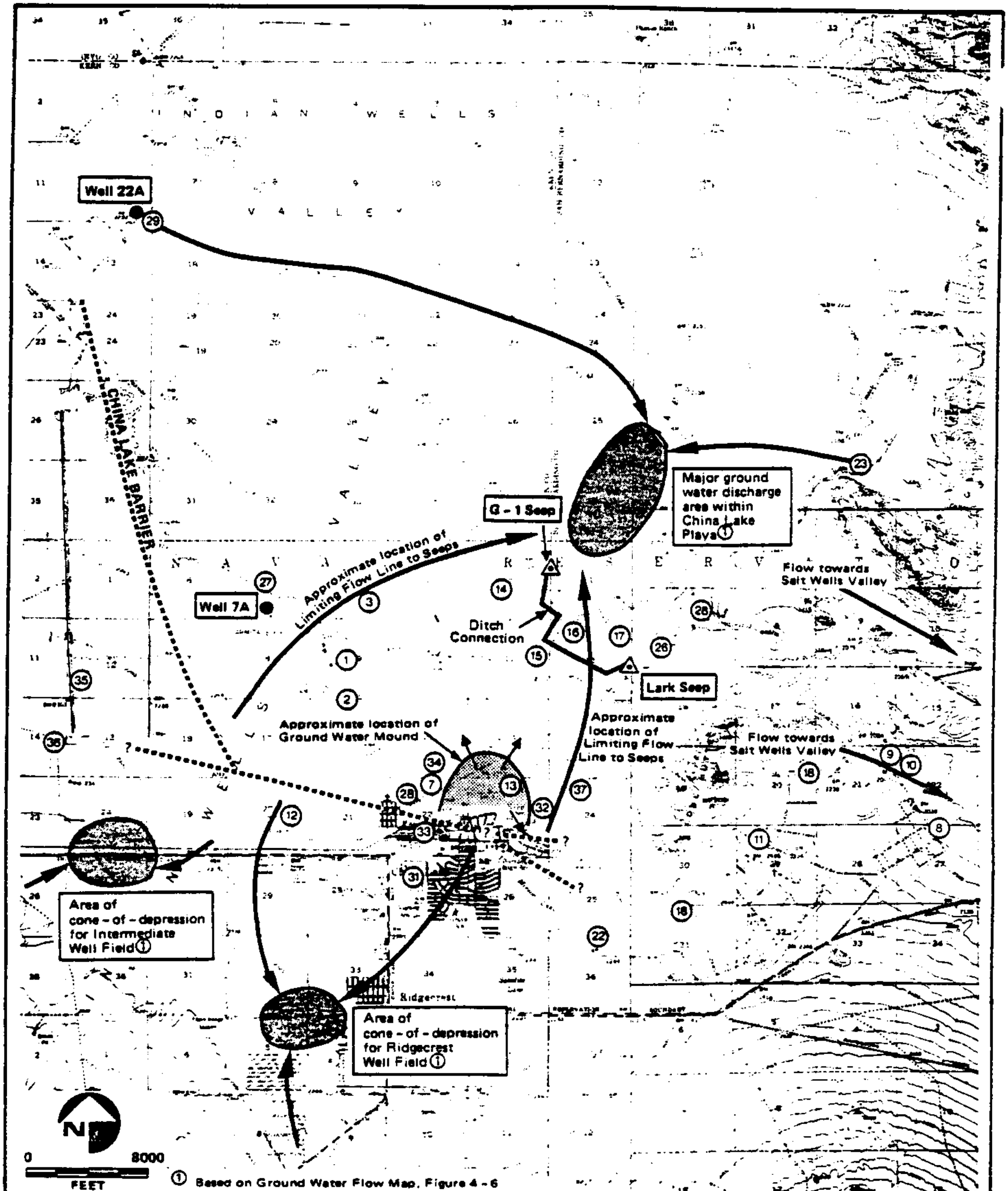
8.1 SITE 1, ARMITAGE FIELD DRY WELLS. From 1945, when Armitage Field was constructed, to 1982, substandard jet fuels (JP-4 and JP-5) and used engine oils were disposed of at the fuel farm area into six (6) dry wells (see Figure 8-2). These disposal methods were discontinued in 1982 when the Lahontan Regional Waste Quality Control Board expressed concern over whether these operations were affecting the quality of ground water in the area. The Navy subsequently authorized several investigations to determine the nature and extent of contamination from these wells and to recommend necessary remedial actions (see ERTEC Western, 1982; ERTEC Western, 1983; and Leedshill-Herkenhoff, 1983). ERTEC Western, estimated that approximately 1,000,000 gallons of waste fuel was disposed of in these dry wells over the 37-year period. Leedshill (1983) determined that 8000 gallons of fuel was disposed of each year in 1981 and 1982. Depth of the dry wells is about 10 feet.

Armitage Field is located on sediments composed primarily of alluvial fan and slope wash deposits, and to a lesser extent on old playa deposits. The upper 25 feet of the site typically consists of brown, calcareous silty sands and sandy silts. Underlying this formation is an old playa lakebed composed of gray sandy plastic clay. Below the old playa deposits in the fuel farm area are clean sands grading to clayey sands to a depth of approximately 40 feet. A layer of relatively clean, fine to coarse sand underlies the playa deposit.

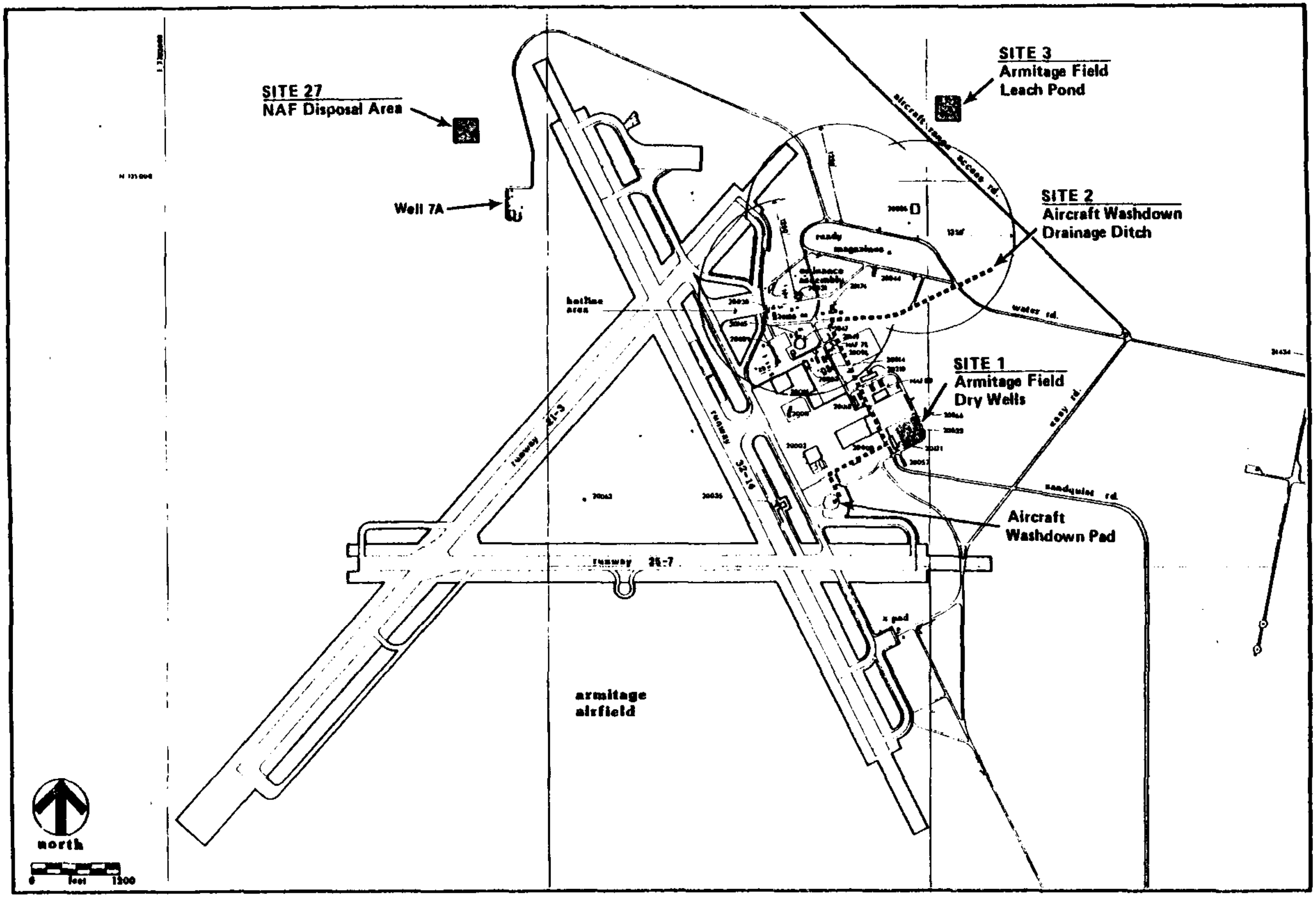
In the fuel farm area, the depth to the water table is generally at about 30 feet and occurs in the clean sands and clayey sands below the old playa deposits. The direction of ground water flow is northeasterly, towards the lower China Lake playa. Locally, the slope of the water-table surface or ground water gradient is 0.0015 feet per foot.

According to Leedshill-Herkenhoff (1983) the porosity of dense clean sands and clayey sands is assumed to be between 0.20 and 0.40 and the average linear ground water velocity at the fuel farm area is between 7 and 45 feet per year toward the northeast.

An assessment of fuel in the ground water underlying the Armitage Field area was conducted for the Navy by Leedshill-Herkenhoff in 1983. For this assessment, a total of 11 soil borings were placed in the fuel farm area, 8 of which were converted to observation wells. Three wells encountered measurable free floating fuel above the water table. Organic vapor readings taken on soil samples collected at approximately the depth of the water table indicated high organic vapor concentrations in three other borings.



INITIAL ASSESSMENT STUDY NAVWPNCEN, CHINA LAKE	Key Sites Relative to Migration Pathways and Receptors	FIGURE 8-1



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Armitage Field Disposal Sites

FIGURE 8-2

This assessment also determined that fuel occurs in clean sands and clayey sands located below the old playa clay deposits. A maximum observed fuel thickness of 2.50 feet was found in one boring and 3.6 feet in a second boring. It was assumed by Leedshill (1983) that between 20,000 and 70,000 gallons of fuel are presently below the fuel farm area. Furthermore, the quality of fuel in the soil and ground water does not appear to have degraded since being placed in the ground.

The main area of ground water pumpage within Indian Wells Valley is located approximately 3 miles southwest of the fuel farm, which is up gradient in the regional ground water system from the potential contamination sources. Water-quality data indicates that the ground water in this area is potentially usable for most purposes. In addition to the well fields in Indian Wells Valley (Figure 8-1), a water well is located just 1 mile northwest of this site. Although not presently used, this well could be a potential source of water supply. Migration from this site also is in the direction of the seeps containing the Mohave chub. This is shown in Figure 8-1. Presently mitigation measures are being contracted out by NAVWPNCEN China Lake to clean up the contaminated ground water and soils.

8.2 SITE 2, AIRCRAFT WASHDOWN DRAINAGE DITCHES. From 1945 to 1982, used engine fluids and wash water containing detergents and degreasers generated by aircraft cleaning and equipment maintenance at Armitage Field were disposed of in unlined ditches (see Figure 8-2). The aircraft cleaning area is a 200-foot diameter pad located west of Runway 32-14 and south of Building 20002. In 1981 a wastewater collection system and oil-water separator was installed at Armitage Field. Prior to 1981, all aircraft washwater and waste fuels were drained from the aircraft cleaning pad to an open unlined ditch which eventually drained to an open field east of Armitage Field. Although it can be assumed that some wastewater evaporated, certain amounts of the wastewater did percolate into the soil underlying the ditch. This open ditch also served as the stormwater drainage system for Armitage Field and this stormwater ultimately diluted the aircraft washwater flow. The compounds that contaminated the wastewater from the washing and maintenance operations included chlorohydrocarbon degreasers, industrial detergents, hydraulic fluids, lube oil, antifreeze and jet fuels. Approximately 10,000 to 20,000 gallons per day (gpd) of wastewater containing aircraft washwater detergents, solvents such as TCE, oils and grease, and jet fuel were discharged to this open ditch. This production rate indicates that 0.25 to 0.5 million gallons of wastewater were released in 37 years (assumes 260 work days per year). If 0.5 percent of this wastewater was contaminant then 1400 to 2700 gallons of contaminant were released to the ditches. Combined with the washwater discharge was about 1000 gpd of boiler blowdown water containing phosphates, sodium sulfides and tannins from Boiler Plant #3.

The soil conditions and migration potential for the area are the same as that discussed under Section 8.1, Armitage Field Dry Wells. Confirmation well borings were drilled by Leedshill-Herkenhoff (1983) in the drainage ditches which confirmed the presence of TCE and fuel in the ground water. This site is undergoing remedial action under the same program as Site 1.

8.3 SITE 3, ARMITAGE FIELD LEACH POND. From 1950 to 1981, sanitary and industrial wastes from Armitage Field operations were disposed of to a central sewer system which conveyed the wastewater to an Imhoff (settling) tank. Effluent from the Imhoff tank flowed to an evaporation/leach pond located on the northeast side of Aircraft Range Access Road (see Figure 8-2). The average daily flow to the leach pond was determined to be about 17,000 gallons per day (gpd) (Lowry, 1978). The waste generated by Armitage Field was predominately domestic sewage. The amount of industrial waste discharged to the sewer system was relatively small with concentrations of metal and oil and grease being low. However, the wash area in Building 20011 discharged nearly 500 gpd of wastewater containing solvents, detergents and oil and grease to the sanitary sewer.

An analysis of effluent to the leach pond showed virtually no reduction in volatile suspended solids from the Imhoff tank influent (Lowry, 1978). It can be assumed that, over a 31-year operational period, the leach pond received approximately 130,000 gallons per year of wastewater containing solvents such as TCE, detergents, and oil and grease contaminants. Assuming only 0.5 percent of the wastewater flow was contaminant then 20,000 gallons of contaminant were discharged.

The migration potential for this leach pond site is the same as that described for Section 8.1, Armitage Field Dry Wells. Based on the Armitage Field migration potential assessment, contaminants from the leach pond would migrate downward into the ground water and towards the seep area. The contaminants include solvents, oils, and grease. These contaminants range from very low to very high mobility. For example, oil may be adsorbed readily in the unsaturated zone, but solvents are very mobile. The travel time for some of the solvents that could migrate from the source to the seeps is on the order of 50 to 100 years.

8.4 SITE 4, BERYLLIUM-CONTAMINATED EQUIPMENT DISPOSAL AREA. During the early 1960s, experiments were conducted on beryllium-based propellants in the Salt Wells Lab area. By 1965 the experiments stopped, all beryllium-contaminated equipment and the structure housing the experiments was burned and buried at Site 4. The site is located in the northeast quarter of Section 2, T26R, R41E in the Salt Wells Valley (see Figure 2-3 in Chapter 2). It has been reported by former NAVWPNCEN employees involved in these experiments that no bulk beryllium was buried at the site. The volume of burned equipment and solid waste material was estimated to be about 900 cubic yards. The amount of beryllium-contaminated equipment that may have been burned could not be determined.

Surficial soils under the site are very sandy and bedrock is probably 25 to 50 feet below the land surface. The bedrock is exposed both north and south of the site, and faults are probably present at or near the bedrock/valley fill contact. The depth to ground water is estimated to be greater than 100 to 200 feet and therefore would be within the fractured bedrock system. It is assumed that ground water quality is poor due to high salinity. At times, there may be water at the soil/bedrock contact. In general, the surface and ground water directions are to the southeast, toward the center portion of Salt Wells Valley which is approximately 4 miles away. In summary, it is unlikely that any detectable amounts of beryllium residue remain at this time. Noting that beryllium is highly adsorbed in the soil and that the water table is very deep, the potential for contaminant migration is small.

8.5 SITE 5, BURRO CANYON. From 1968 to about 1979, hazardous waste chemicals were delivered to Burro Canyon and disposed of by burning and detonation (see Figure 2-2 in Chapter 2). Burro Canyon was commonly used to burn and destroy

PEP materials such as TNT, compound B, and vinyl compounds. Unknown non-PEP hazardous chemicals were brought to the site and burned with the PEP materials (Ertec, 1982). It is estimated that about 3 tons of these hazardous chemicals a year were burned at this site. A total of 1200 cubic yards of these waste materials is reported to have been burned over an 11-year period. There is no data available indicating an amount of unburned material that may be present in the soil. Metal scrap, ash and other residue material are still visible at the surface of the site. Burro Canyon continues to be used for the disposal and burning of some PEP-type materials; however, no additional non-PEP hazardous waste materials are delivered to the site.

The Burro Canyon site is located within a deep granitic canyon. The soils consist primarily of course sands and alluvial deposits that include size fractions up to large boulders. Depth to bedrock is reported at 300 feet and the water table is below the bedrock/unconsolidated interface. It is assumed that ground water within the fractured bedrock or at the above mentioned interface, flows westerly towards North Lake Playa. Surface water drains west towards North Lake Playa. During periods of heavy rain the site has the potential for surface flooding.

The main potential mechanism for contaminates migrating from this site appears to be from surface flooding. Infrequent flood waters which inundate the site could transport contaminants towards Indian Wells Valley. However, the concentration of contaminants in the flood waters would be insignificantly low if present at all. Therefore it is highly unlikely that the ground water system under Indian Wells Valley would be contaminated from Burro Canyon flood waters.

8.6 SITE 6, T-RANGE DISPOSAL AREA. The T-Range disposal area consists of two open trenches and an air curtain incinerator all of which are currently still in operation. Past operations included the disposal of wastes in nine trenches, all of which are now closed. From 1946 to 1975 this range site was used to dispose of PEP materials, explosive-contaminated waste trash (hexane-laden with propellant) and hydrazene from the Salt Wells Lab area (see Figure 2-3 in Chapter 2). The primary method of disposal was by open burning of wastes, after which waste residuals were buried in open trenches. The nine (9) slit trenches, measuring 100 feet long by 12 feet wide and 7 feet deep, were used. Estimates show that during an average month approximately 2750 gallons of hydrazene, 500 pounds of high explosives, 1500 pounds of other PEP materials, along with some live ordnance, were burned at this site. Any explosions were accidental. An air curtain incinerator is used in the burning of some waste materials. Any residue and wastes remaining from the burning operation are buried in the adjacent trenches.

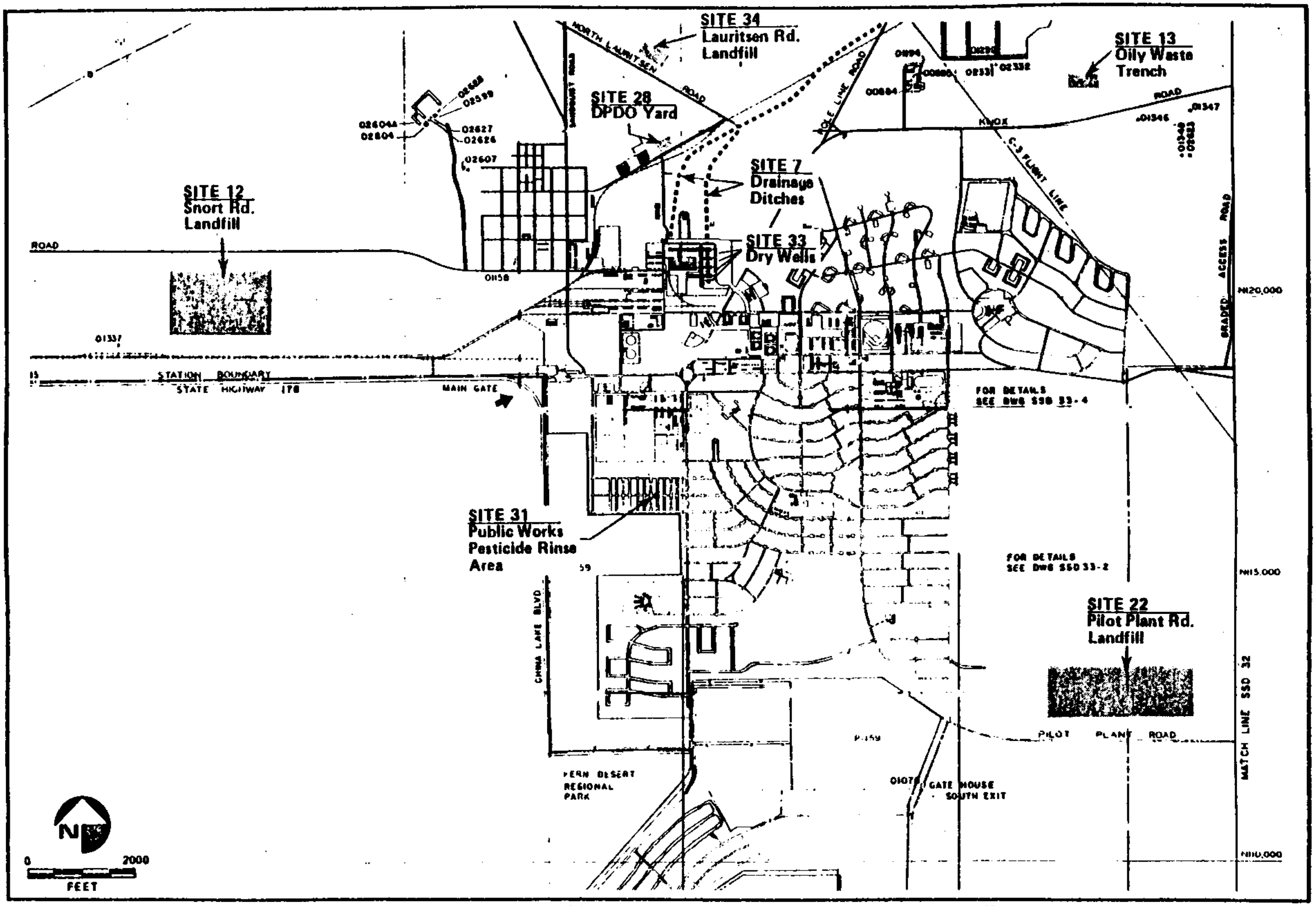
The surficial material at this site is sandy with many rock outcrops scattered throughout the area. Depth to bedrock has been reported to range between 50 and 100 feet and ground water is below the bedrock divide. This bedrock surface slopes toward the south and southeast direction. Ground and surface water flow locally toward Salts Wells Valley. According to data from the U.S. Geological Survey, the ground water is thought to be saline with total dissolved solids (TDS) in excess of 20,000 parts per million. Based on the assumption that ground water is more than 100 feet below surface, the potential for contaminate migration to the ground water is small. If contaminants reached the ground water, the migration would be to Salt Wells Valley which is a highly saline, unuseable water source.

8.7 SITE 7, MICHELSON LABORATORY DRAINAGE DITCHES. From 1947 to 1981, acid and chemical wastes were discharged from the Michelson Laboratory to two unlined drainage ditches. The ditches ran in a northeast direction from the lab (see Figure 8-3). The western most ditch ran for a distance of 1-3 miles and discharged into an open area. The longer and more western ditch received wastes from the plating/etching machine shops and the photographic shops. This ditch received primarily acids, heavy metals, cyanides and TCE. The eastern ditch, which ran only 0.5-1 mile in length, served the research labs and, as such, received various types of lab chemical wastes. It has been reported that the small east ditch had a flow rate of approximately 9400 gallons per day (gpd) while the west ditch had a flow of 62,000 gpd. Chapter 5 provides an inventory of wastewater sources, volumes, and chemicals discharged from Michelson Lab to the west and east drainage ditches.

The surficial soils in the area of Michelson Laboratory are reported as silty sands. These sands overlie the confining layer which is clay. Ground water occurs in unconfined conditions above the clay layer and in confined conditions below the clay. The depth to ground water is from 20 to 60 feet below the surface. In general, ground water flows to the north towards China Lake Playa and the seeps, which are about 2 miles to the northeast. However, leaking sewers, vegetation irrigation, and seepage from sewage evaporation ponds is providing substantial recharge to the ground water. Because of this increased recharge, a ground water mound has resulted which can cause localized flow patterns to change from the north to the south, east, and west directions. This may result in water in the shallow aquifer to flow across the clay barrier toward the water well fields in Ridgecrest.

The Navy has recognized the potential of contaminant migration from the Michelson Laboratory drainage ditches. This has been documented by Ertec (1983) and Engineers Testing Laboratories (1981). However, data gathered to date is inadequate for verification purposes. Detection limits for many analyses conducted are too high by today's standards.

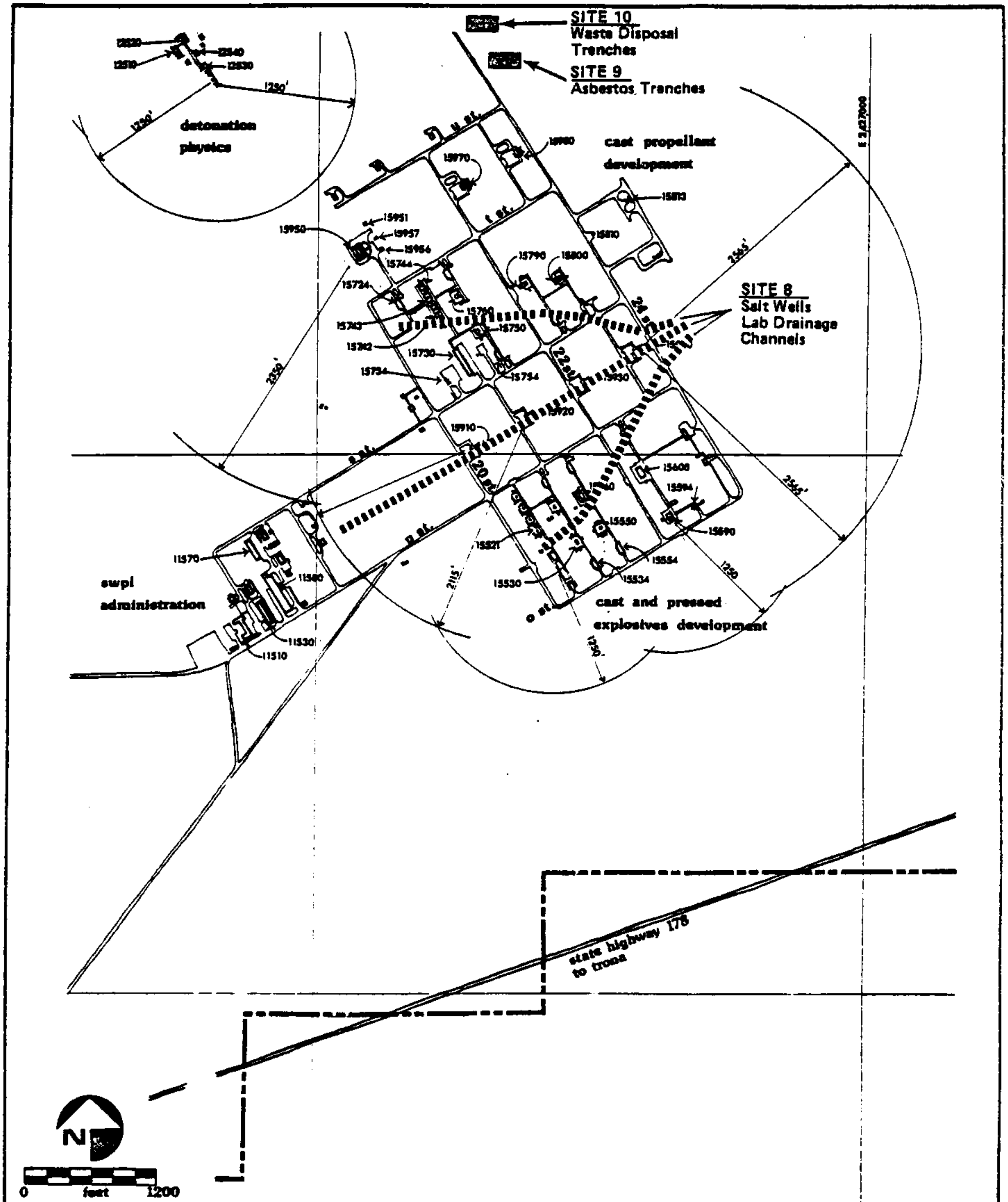
8.8 SITE 8, SALT WELLS DRAINAGE CHANNELS. The Salt Wells laboratory complex consists of 20 small, individual facilities located in Section 21, 22, 27, and 28 of T26S R41E in the Salt Wells Valley (see Figure 8-4). From 1946 to 1981 wastewater from the labs was discharged to open drainage channels. In 1981 clay-lined evaporation ponds were constructed in place of unlined ponds. It has been suggested that wastewater in the drainage channels percolated into the soils and to the ground water (Ertec, 1982). The chemical wastes discharged included ammonium perchlorate, TNT-washwater, and isocyanates. The explosive-related wastewater that was discharged is described as a water/explosive slurry. It was generated when equipment used to produce explosives was washed. The labs also discharged TNT contaminated water known as "pink water." Pink water reportedly breaks down to nitrates and toluene and is highly adsorbed and biodegraded in the soil. As determined in Chapter 5, the total volume of wastewater discharged to drainage ditches was approximately 14,150 gallons per day. The wastewater contaminants generated by each lab building are listed in Chapter 5.



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Base Administration and Lab Area Disposal Sites

FIGURE
8-3



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NAVWPNCEN, CHINA LAKE

Salt Wells Propulsion Lab (SWPL) Disposal Sites

FIGURE 8-4

Both ground and surface water flow northeast to east toward the center of Salt Wells Valley. According to ERTEC (1983), if a hydrologic connection exists between Indian Wells Valley and Salt Wells Valley, ground water at the site could be as shallow as 50 feet. If no connection exists, water could be deeper than 150 feet.

It is assumed that the ground water is relatively deep and migrating towards Salt Wells Valley and eventually to Searles Lake. The water quality in these areas is very poor; reportedly total dissolved solids is as high as 20,000 parts per million. Therefore, if contaminants reached the ground water, migration to Salt Wells Valley would not be a problem since this area is not used as a potable water source nor would it threaten an endangered species.

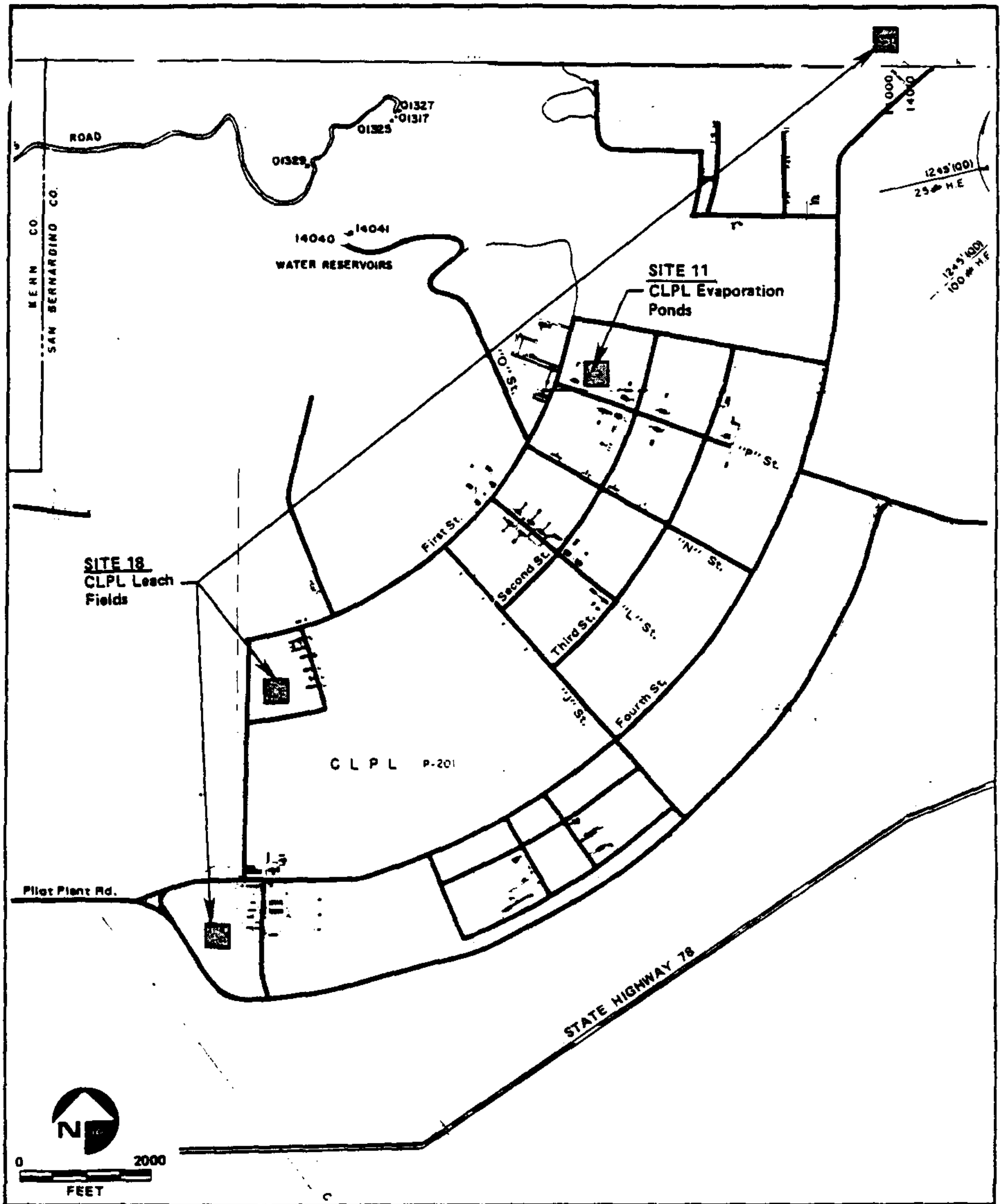
8.9 SITE 9, SALT WELLS ASBESTOS TRENCHES. From 1979 to 1981, waste asbestos was buried in three slit trenches in an area north of Salt Wells Labs (see Figure 8-4). The trenches measured approximately 50 feet long by 10 feet wide and 10 feet deep. It has been estimated that approximately 300 cubic yards of asbestos was disposed of at this site over the 2-year period. Asbestos brought to this site was generated by all NAVWPNCEN activities. Some asbestos was contained in plastic bags, however, much of the waste was loose and buried without protection. The trenches were closed (and filled) in 1981.

The ground water flow characteristics of this site is similar to Site 8. Asbestos is the contaminant of concern and the potential for migration of asbestos to the ground water is very low. Airborne asbestos would be a threat to human health but burial has eliminated that potential problem.

8.10 SITE 10, SALT WELLS DISPOSAL TRENCHES. From 1960 to 1980, all solid waste and some liquid wastes generated by the Salt Wells Lab and China Lake Propulsion Lab areas were disposed of in 10 slit trenches north of the Salt Wells Lab area. The trenches measured 100 feet long by 12 feet wide and 8 feet deep (see Figure 8-4). The waste consisted of lab solid wastes, empty cans and barrels, construction debris, wood, used metal equipment, and some solvents such as TCE and liquid chemicals. Total volume of wastes is estimated at approximately 2500 cubic yards.

The ground water flow and contamination migration characteristics for this site are similar to Site 8. The potential for contaminant migration to the ground water is minimal. If contaminants did reach the ground water, migration to Salt Wells Valley would not result in a threat to a potable water source or human health and the environment.

8.11 SITE 11, CHINA LAKE PROPULSION LAB (CLPL) EVAPORATION PONDS. Wastewater generated by CLPL Buildings 10570 and 10580 was discharged to two unlined evaporation ponds. The ponds were built in 1946 and were located just east of each building (see Figure 8-5). Propellants, AP, and RDX were reportedly machined in these buildings (Dodohara and Davis, 1979). Dust from the operation was separated by a water-aspirated vacuum system. The wastewater was discharged to the ponds. Wastewater contaminants include RDX and AP washwater, and some powdered metal from the propellants such as aluminum. The volume of discharge is not known. In 1981, the ponds were replaced with new clay-lined ponds at the same locations.



INITIAL ASSESSMENT STUDY NAVWPNCEN, CHINA LAKE	China Lake Propulsion Lab (CLPL) Disposal Sites	FIGURE 8-5

WESTEC Services, Inc.

Ground water in the area of CLPL evaporation ponds appears to be near a divide. Depending on the location of the divide, the flow direction of the potential contaminant migration path can either be northeast towards Salt Wells Valley where there are no known receptors or south and west towards Indian Wells Valley. If the contaminant flow was towards the Indian Wells Valley, there is a potential for ground water contamination problems. However, the depth to water is between 100 and 300 feet below land surface and the nearest water supply wells are about 6 miles away. As the depth and distance is so great, there is a high potential for most of the contaminants to be adsorbed, attenuated and dispersed. Using the aquifer parameters discussed in Chapter 4 would indicate that contamination would take more than 300 years to reach the well supplies.

8.12 SITE 12, SNORT ROAD LANDFILL. From 1952 until 1979 some NAVWPNCEN solid waste went to the SNORT Road Landfill disposal site. The site is located on the south side of SNORT Road on the way to the SNORT Track (see Figure 8-3). Public Works records show that approximately 100 tons a year of solid wastes were delivered to the site. The wastes included tree trimmings, construction debris, cans and barrels, small electrical parts, plastics and rags. No household garbage was disposed of at this site. Evidence suggests that some hazardous wastes were also disposed of including solvents such as TCE, waste oils, liquid chemical wastes and some PCBs from small capacitors. However, the volume of hazardous-type wastes could not be determined.

The SNORT Road Landfill is in a sensitive ground water area as seen on Figure 8-1. It is on the south side of the China Lake Barrier and therefore ground water migrates in a southerly direction toward the public water supply wells in Ridgecrest. The site is less than 3 miles from these wells. As there is major pumping from these wells, the hydraulic conductivity must be greater than the values for the Armitage Field area. It can be assumed that the hydraulic conductivity is greater than 1000 gallons per day per square foot (gpd/ft^2). As the gradient is about 0.001 in this area, the velocity of ground water flow may be as high as 200 feet per year. This indicates a travel time of contaminant migration to the water supply wells to be about 80 years or less.

8.13 SITE 13, OILY WASTE DISPOSAL AREA. From about 1965 to 1980 waste oils were disposed of in two unlined trenches located east of the sewage treatment plant and north of Knox Road (see Figure 8-3). The trenches measured about 100 feet long by 10 feet wide and 5 feet deep. The trenches were used only for oily liquid wastes which may have included motor oils, solvents such as TCE and grease from grease traps at cafeteria facilities. It has been estimated that approximately 10,000 gallons of oily wastes were disposed of over the 15-year period. The site was filled in and closed in 1980.

The oily waste trenches are on the north side of the China Lake Barrier and historically would migrate toward the G-1 and Lark seeps. However, because of ground water recharge from the sewage treatment evaporation ponds (see discussion in Chapter 4) some of the shallow ground water flow may be shifting to the south. It has been reported that shallow ground water, which is at a depth of 20 feet or less, can flow past the barrier and onto the south towards the water supply wells (see Figure 8-1). However, there is no convincing evidence that this is occurring.

It is more likely that oil from the trenches may have formed a product which is now floating on top of the ground water. Both the product and its soluble compounds may be migrating north towards the seeps. If the velocities discussed in Chapter 4 for Armitage Field are similar to the oil in ground water movement here, then migration to the seeps would take less than 100 years.

8.14 SITE 14, ER RANGE SEPTIC SYSTEM. The ER Range Septic System was once the nucleus of five septic tanks and one leach field located 1500 feet directly southwest of Building 31436. The point of generation or source of contamination included the Anti-Radiation Laboratory Buildings 31434 and 31440, and the Thompson Laboratory Buildings 31433 and 31439. The old septic system location is depicted in Figure 8-6.

The five septic tanks of this system became operational in 1950 and were abandoned in 1981. The type of waste received at the site consisted of etching, cooling tower, and sanitary wastewater. The estimated total flow of wastewaters was 11,330 gallons per day of which 30 gpd was etching wastewater. Thus, assuming 260 work days per year and 31 years of discharge nearly 0.25 million gallons of etching contaminated wastewater was discharged to the soil.

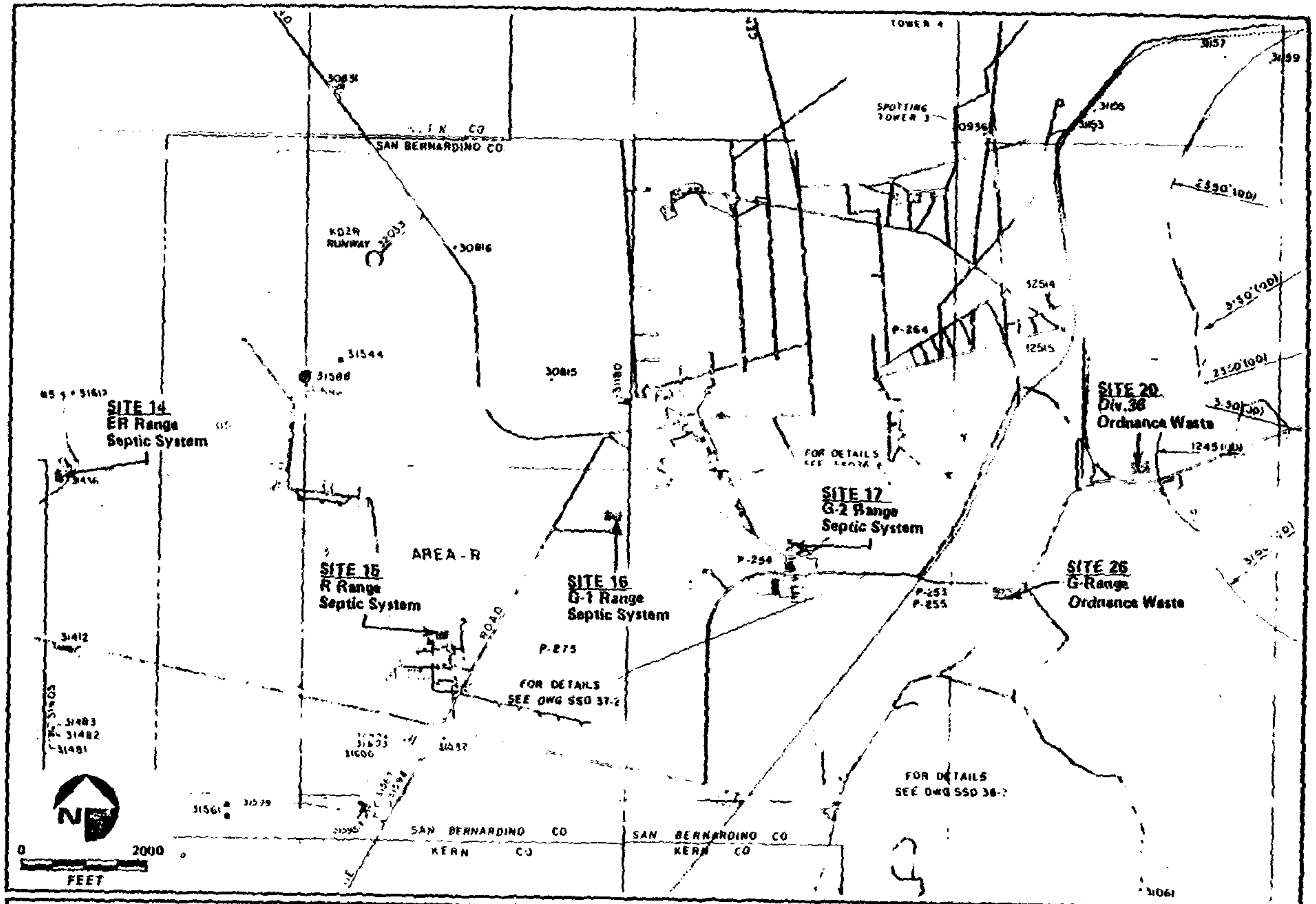
The depth to water for this area is shallow, about 10 feet below land surface. Contaminants from this site will migrate in a northerly direction towards the G-1 seep which is less than 1 mile away. The contaminants vary in mobility from high to low. As the gradient is steep in this discharge area, the velocity of ground water may be about 200 feet per year (see Chapter 4). Therefore, it would take on the order of 10 years for contaminants to reach the seep receptor.

8.15 SITE 15, R-RANGE LEACH FIELD. The R-Range Leach Field was the nucleus of 5 septic tanks that were located 1100 feet north-northeast of the intersection of Water and Pole Line Roads. The R-Range Leach Field site is shown in Figure 8-6. Between 1950 and 1980, this site received sanitary waste as well as dilute solvents. The wastes reaching the R-Range Septic System site were generated by all buildings of the R-Range complex. In addition, the Earth and Planetary Science Building 31598, and Building 31504 were also sources from which the wastes originated. The estimated total flow of these wastewaters to this site was 9530 gallons per day of which 60 gpd was solvents and photo lab wastes. Therefore, nearly 0.5 million gallons of contaminated wastewater was discharged at this site.

Site 15 is also in the China Lake Playa's drainage system as shown on Figure 8-1 and therefore the potential for contaminants to migrate from this site to the G-1 seep is similar to Site 14. It is estimated that the time of travel for these contaminants to reach the seep will be less than 10 years.

8.16 SITE 16, G-1 RANGE SEPTIC SYSTEM. This site is located 1500 feet east from the intersection of Tower and Pole Line Roads. The G-1 Range Septic System site is shown in Figure 8-6. The septic system site included 12 septic tanks abandoned in 1981 after having been in use since 1950. It is unknown how many leach fields were used to serve the 12 septic tanks.

The type of waste material received at this site included sanitary and photo lab wastes. The maximum flow of sanitary wastes was 1800 gallons per day. The maximum daily flow of wastewaters from the photo lab was 30 gallons per day.



INITIAL ASSESSMENT STUDY
NAVWPNCEN, CHINA LAKE

Range Area Disposal Sites

FIGURE 8-6

Therefore, it can be estimated that approximately 0.25 million gallons of photo lab contaminated wastewater was discharged at this site. The sanitary wastes were generated by several buildings in the G-1 Range complex and the photo lab wastes were generated by the operations in the Telemetering Building 30881.

The potential for contaminants to migrate from the site is similar to Sites 14 and 15. Migration is toward the G-1 seep. It is estimated that the time of contaminant travel from the site to the G-1 seep will be less than 10 years.

8.17 SITE 17 - G-2 RANGE SEPTIC SYSTEM. This site is located 200 feet directly north of the Explosive Ordnance Disposal unit Building 30994. Location of the G-2 Range Septic System site is shown in Figure 8-6. The septic system site included three septic tanks and apparently one leach field that received wastes from 1950 until their abandonment in 1981.

The waste materials generated at this site were mostly sanitary wastes and some explosive and photo lab wastes. The estimated total flow of all wastes to the site is 4600 gallons per day of which 100 gpd was explosive and photo lab wastes. Therefore, about 0.75 million gallons of wastewater contaminated by explosives' residues of unknown type and photo lab wastes were discharged over 31 years. These waste streams ae expected to be contaminated by various metals (OESO, 1984).

This site is also in the Playa drainage system as seen on Figure 8-1. Therefore, the potential for contaminants to migrate from this site to the G-1 seep is similar to Sites 14-16. Migration time to reach the seep is expected to be less than 10 years.

8.18 SITE 18, CHINA LAKE PROPULSION LAB (CLPL) LEACH FIELDS. The CLPL Leach Fields site incorporates three abandoned septic tanks with three separate leach fields located as follows: one located in the old China Lake Administration area just south (40 feet) of Building 105; one located at the old China Lake experimental line just west (40 feet) of Building 304; one located at the old China Lake static firing area, approximately 2000 feet north-northeast of Building 217. Location of the CLPL Leach Fields site is depicted in Figure 8-5. The CLPL Leach Fields became operational in the early 50s and their use was discontinued in 1981. Waste materials discharged to the system included phosphates, sulfides, dilute explosives such as RDX and TNT, TCE, oil, grease, ammonia, dilute propellants, and photo lab waste chemicals. Wastewaters containing these contaminants were discharged to the leach fields at a rate of about 7500 gallons per day.

The potential for contaminants to migrate from this site is similar to Site 11, CLPL Evaporation Ponds. However, the concern is even less, as these leach fields did not have constant head of water as did the evaporation ponds. Depth to water is 100 to 300 feet and the nearest water supply wells are 5-6 miles away. There is a high potential for attenuation through adsorption, dilution, and dispersion.

8.19 SITE 19, BAKER RANGE WASTE TRENCHES. From 1944 to the present, range waste from Baker Range was disposed of in one long trench located about 1500 feet south of the B1 Range buildings (see Figure 2-2 in Chapter 2). This site was one of the largest open disposal sites at NAVWPNCEN. The trench measured

450 feet long by 25 feet wide and about 10 feet deep. The range wastes consisted of range target debris, wood, scrap metal, tires, plastic, construction debris, electronic parts and concrete. It has been estimated that approximately 3000 cubic yards of solid wastes was disposed of at this site. No toxic or contaminated wastes were identified as being disposed of at this site.

Ground water is flowing easterly from this site toward China Lake Playa, which is over 11 miles away as shown on Figure 8-1. The major production wells which are not in the direction of flow, are over 9 miles away. In addition, the depth to water is estimated to be greater than 50 feet therefore the potential for unknown contaminants to migrate from this site to a receptor is minimal.

8.20 SITE 20, DIVISION 36 ORDNANCE WASTE AREA. From the late 1960s to 1979 range wastes and ordnance-type waste from the Division 36 area were disposed of in two slit trenches (see Figure 8-6). The material disposed of included typical NAVWPNCEN range wastes such as construction and target demolition debris, concrete, steel and wood, as well as bomb casings and other solid wastes. Total volume of wastes has been estimated at approximately 600 cubic yards. The site was closed and filled in 1979. The site contains inert wastes and therefore has no potential for contaminant migration.

8.21 SITE 21, CT-4 DISPOSAL AREA. Between 1956 and 1979, residual materials from special weapons testing in the CT Ranges were disposed of in a small open ditch at the end of the CT access road (see Figure 2-3 in Chapter 2). The ditch measured 200 feet long by 50 feet wide and 10 feet deep. Disposal waste included PEP materials, depleted uranium, radium dials, wood, concrete, metal, plastics, cans and barrels some of which contained residual chemicals, solvents and oils. Not more than 100 pounds of solid waste were disposed of each week. Total volume of wastes buried is estimated at 2000 cubic yards.

Ground water is at a depth of about 100 feet (Ertec, 1983) and the migration path is toward Salt Wells Valley. The potential to migrate to Salt Wells Valley is low and this pathway does not lead to a useable water source or a sensitive environmental resource.

8.22 SITE 22, PILOT PLANT ROAD LANDFILL. From 1944 to 1965 a majority of NAVWPNCEN domestic solid waste generated by the Navy Housing and Public Works was disposed of in 12 large trenches located just north of Pilot Plant Road and 1 mile west of the China Lake Propulsion Lab entrance (see Figure 8-3). In addition to the domestic wastes, pesticide containers (some still containing liquid pesticides) and barrels partially filled with oil and solvents, such as TCE, were disposed of in these trenches. Reportedly, some paints and thinners were deposited. Quantities could not be determined. Usually three slit trenches were open at a time and while one was being filled, the others were set on fire and allowed to burn through the evening. At the time when each trench was closed, it usually measured 200 feet long by 30 feet wide and 15 feet deep. It has been estimated that 110,000 cubic yards of waste material were disposed of in the 12 slit trenches by the time the area was closed in 1965.

This site is in a sensitive area in relationship to ground water flow as seen in Figure 8-1. It is south of the ground water barrier in an area where the shallow confining layer may be non existent. Therefore, any contaminants from the landfill may enter the main aquifer and migrate toward the water supply wells. The site is less than 3 miles from the well field. The main aquifer probably has a hydraulic conductivity greater than the upper aquifer and therefore, contaminants may migrate more quickly in this aquifer.

8.23 SITE 23, K-2 SOUTH DISPOSAL AREA. Between 1951 and 1981 range wastes were disposed of in three (3) slit trenches located in the K-2 range area (see Figure 2-2 in Chapter 2). Range wastes included construction and demolition debris, bomb casings, concrete, wood, and metals. More importantly was the one-time disposal of approximately 17,000 gallons of chlordane at this site. This chlordane disposal was part of a larger chlordane disposal event that also included the C-1 East Disposal Area (Site 29). Source of the chlordane, which was in one and five gallon metal containers, was reportedly from a Navy installation at Barstow, California. The event was reported to have occurred in the 1970s. This disposal site was closed in 1981.

The potential for migration from this site to any water supply wells is low as the site is over 9 miles from the nearest well field and will instead flow to the China Lake Playa discharge area as seen on Figure 8-1. The contaminant of interest, chlordane, is not very mobile as discussed in Section 4.5. It cannot migrate across the Playa to the nearest receptor of interest which is the G-1 seep containing the endangered Mohave chub.

8.24 SITE 24, K-2 NORTH DISPOSAL AREA. Between 1950 and 1981, range wastes like those described above for K-2 South where disposed of in two slit trenches located in the north end of the K-2 Range (see Figure 2-2 in Chapter 2). Approximately 1000 cubic yards of waste materials are estimated to have been buried at the site. The material deposited at this site is considered inert and, therefore, no contaminant migration is expected.

8.25 SITE 25, G-2 RANGE DISPOSAL AREA. Between 1944 and 1958 inert range wastes were buried in three slit trenches in the G-2 Range area (see Figure 2-2 in Chapter 2). The trenches measured 100 feet long by 8 feet wide and 6 feet deep. Total volume of range-type wastes is estimated at 600 cubic yards. The type of range wastes are similar to that described for Site 19 and 20. As the material disposed of at this site is considered inert there are no contaminants of concern.

8.26 SITE 26, G-RANGE ORDNANCE WASTE AREA. Between 1950 and 1979, range wastes, such as concrete rubble, metals, bomb casings, and wood, were disposed of in two slit trenches on the north end of G Range (see Figure 8-6). Volume of waste was about 500 cubic yards total. Each trench measured 100 feet long by 8 foot wide and 6 feet deep. The material disposed of at this site is inert; therefore, no contaminants of concern have been identified.

8.27 SITE 27, NAF DISPOSAL AREA. From 1945 to 1978, a large majority of the solid and liquid wastes generated by aircraft operations were disposed of in two or three trenches located 0.5 mile west of the (Armitage) Naval Air Field (NAF) (see Figure 8-2). Waste materials included empty and partially full paint and solvent cans, old engine parts (non-salvagable) and the Group 3 wastes such as wood, concrete, metal, paper, rags, etc. More than 2000 cubic yards of wastes were disposed of in these 100-foot long trenches during the 33-year period.

The potential for migration of contaminants from this site is very similar to the other Armitage Field sites (see discussion of Site 1). The flow of contaminants will be toward the China Lake Playa and the seeps (as shown on Figure 8-1). In addition, Well 7A is within 0.5 mile of the site. This well is presently not in use but it was used in the past and may still be used for irrigation and public supply. Therefore, there is potential for contaminants to migrate toward the well if it is pumped in the future.

8.28 SITE 28, OLD DPDO STORAGE YARD. From about 1965 to 1970, a Defense Property Disposal Office (DPDO) was located on Iwo Jima Road (see Figure 8-2). The only wastes that may contaminate this site are PCBs from used, leaking transformers and capacitors. However, no information was obtained regarding any actual PCB spills or whether transformers stored onsite actually leaked. No information is available regarding the number of transformer stored or the location on the DPDO site where they may have been stored. The old DPDO site was moved in 1970 to the present DPDO location. There currently is no visible evidence at the DPDO site of any spills and the site has essentially reverted back to a desert habitat. There is no evidence of PCB spills at this site.

8.29 SITE 29, C-1 EAST DISPOSAL AREA. From the 1950s to the late 1970s, range waste, live ordnance and chlordane have been disposed of in a series of three trenches located 1000 feet east of the C-1 Tower (see Figure 2-2 in Chapter 2). Site surveys and interviews have substantiated the one-time disposal of approximately 17,000 gallons of unused concentrated chlordane by burial sometime in the 1970s. Remaining (in 1 and 5-gallon metal containers) on the surface of the site are still several pallets of full chlordane cans. Specifications off of the chlordane can label showed that the content was 2 percent technical chlordane (consisting of octachloro -4,7 methane, tetrahydroindane and related compounds) together with 98 percent kerosene. It was also reported that approximately 4000 gallons of lead-based paint in 1- and 5-gallon cans was buried at this site. Other wastes in the form of solvents and oils were disposed of in lesser quantities. The C-1 East site is also reported to contain live ordnance that was hauled in off of the ranges. Signs are posted at several points warning "Do not dig-live ordnance buried." The volume or the type of ordnance buried could not be determined except that it has been reported that a significant quantity of flare primer cord was disposed at this site. The site trenches were closed in the late 1970s and currently used radar equipment parts are stored on the site surface. It should be emphasized that the C-1 Range East Disposal Area is immediately adjacent to and bounded by two impact/target areas. The distance of the disposal area from either of the two impact/target areas is approximately 1000 yards.

It is highly unusual that live ordnance may be intentially disposed of by burial. It is generally accepted that impact and target areas owned by the U.S. government, operated by U.S. Forces, and subjected to live bombing runs will never be turned over to the civilian authorities. For that reason, these impact/target areas are normally always off limits to "all personnel" except for EOD personnel that may enter these areas to recover, render safe, or destroy-in-place dudded ordnance ammunition, munitions, and devices. EOD units diligently seek to locate unrecovered live ordnance in instances where such recovery lends itself to evaluating in the research, development, testing and evaluation (RDTE) effort. However, in the case of the C-1 Range East Disposal site, EOD recovery operations may not have been justified in view of the very close proximity of the site to the two known existing impact/target areas and in view of the possibility that no need for evaluation existed. Thus, it may have been more economical to bury "in (or near) place."

The potential for contaminant migration from this site to sensitive areas such as the major public water supply well fields and the seeps near the China Lake Playa is low. As seen on Figure 8-1, the site is outside the zone of migration towards the seeps. The large well fields and Playa are over 9 miles from the site. However, there is a water well (W-22A) seen on Figure 8-1 within 0.25 mile of the site. It is used for irrigation and potable water supply. The contaminant of interest is large volumes of chlordane. Chlordane has a low potential to migrate as it is highly adsorbed on soils. However, as chlordane is considered very hazardous and pumping may draw contamination towards the well, further analysis needs to be carried out to determine the potential to reach the receptor.

8.30 SITE 30, C-1 RANGE WEST DISPOSAL AREA. From the 1950s to the late 1970s, range waste (such as concrete, wood, metal, and bomb casings) and reportedly some live ordnance were disposed of in two slit trenches located west of the C-1 Range Tower (see Figure 2-2 in Chapter 2). The live ordnance waste disposal is similar to that described for Site 29, C-1 East. The volume or type of live ordnance could not be determined by the IAS team.

The physical setting of this site is similar to Site 29. The wastes are inert and, therefore, no contamination migration problem exists. Live ordnance contamination occurs in the area and access is properly regulated. No immediate threat to human health on the environment is evident.

8.31 SITE 31, PUBLIC WORKS PESTICIDE RINSE AREA. From 1945 to 1980, contaminated pesticide and herbicide rinse water and some concentrated solutions of pesticide and herbicide were spilled on the ground in an area south of 7th Street behind the public works area (see Figure 8-3). Some of the chemicals used were Malathion, Diazanone, DDT, Chlordane, Vapoma, 2-4-D, 1-2-4-D, and 1-2-4 T. Pest and weed control operations were conducted on base by an outside contractor. Volumes of pesticide or herbicide spilled over the life of the operation are difficult to ascertain. However, the IAS was able to determine that as much as 2000 gallons of mixing and rinsing waste water may have been drained onto the soil each year. The concentration of pesticides in the rinse water was probably less than 1 percent by volume. Therefore, over 35 years as much as 700 gallons of pesticide may have been discharged to the soil. This mixing practice was discontinued in 1980 when a concrete-lined drainage pad was installed on this site. The pad now drains the rinsewater to an underground holding tank.

This site is located over the main aquifer within 1.5 miles upgradient of the public water supply well field as seen on Figure 8-1. Therefore, the potential of contaminant migration to this well field is high. It is estimated that it would take about 40 years for contaminants to reach the receptor.

8.32 SITE 32, GOLF COURSE PESTICIDE RINSE AREA. From the mid 1960s until about 1980, pesticide mixing and some rinsing of pesticide containers and equipment were also done at the Golf Course site (see Figure 2-3 in Chapter 2). Reportedly, this site was used only half as much as Site 31 so, perhaps, 1000 gallons per year of wastewater were spilled. Over 15 years, assuming 1 percent is pesticide, about 150 gallons of pesticide were discharged to the soil.

As seen on Figure 8-1 this site is in a similar physical setting as Site 13, Oily Waste Trenches. Therefore, contaminants may migrate north 2-3 miles toward the G-1 and Lark seeps. There is also a possibility, due to man-made recharge, that the direction of ground water flow can change in the shallow aquifer. If this does occur, contaminants can migrate south 3-4 miles toward the well field in Ridgecrest. Therefore, in either case the migration pathways lead to a receptor.

8.33 SITE 33, MICHELSON LABORATORY DRY WELLS. From the late 1950s to the 1970s Michelson Lab had floor drains in auxiliary or backup power rooms which led to four unlined dry wells. Backup power consisted of large storage batteries. Occasionally batteries were drained or fluids were spilled such that battery acid would enter the drains and thus be directed to the dry wells. The wells were located between the east wings of Building 00005 (see Figure 8-3). Three of the four wells have been filled in and the fourth is no longer in use. Specific quantities of battery acid drained to the wells could not be determined, however, it was reported to the IAS team as being very small quantities, probably less than 10 gallons per year. The research effort did not indicate any reason to suspect that the wells were used for any other disposal purposes. The potential for small amounts of acid contaminants to migrate through the soil is low as described in Section 4.5. Therefore, migration to a receptor from this site is not expected.

8.34 SITE 34, LAURITSEN ROAD DISPOSAL AREA. From 1944 to the 1950s, solid wastes were disposed of in several trenches on the north side of Lauritsen Road (see Figure 8-3). The trenches measured 100 feet long by 15 feet wide and 10 feet deep. Solid waste was composed mainly of Group 3-type wastes such as construction debris, wood, concrete and metal. Some liquid wastes including TCE, lab chemicals, waste oil containers and partially full pesticide containers were disposed of at this site. It has been estimated that about 2000 cubic yards of material had been disposed of over the life of the site.

This site is located just north of the China Lake barrier as seen on Figure 8-1. However, as mentioned previously a new ground water recharge zone may cause a potential for contaminants entering the shallow aquifer to migrate either north toward the G-1 seep, or south to the major well fields. Time of travel would be less than 100 years.

8.35 SITE 35, SNORT TRACK ACCIDENT. The SNORT Track Accident is a site where an incident involving the accidental release of Beryllium occurred. The site is located along the SNORT Track 3000 feet from the breach end (see Figure 2-3 in Chapter 2). This site is estimated to be 10 foot wide by 10 foot long. The accident occurred in 1961. The accident occurred when approximately 4 pounds of Beryllium used as a propellant for a 155 mm projectile was released when the projectile detonated accidently in the gun. The dust residue and associated contaminated materials were cleaned up and buried at the site.

The depth to water at this site is about 100 feet below land surface. Beryllium does not migrate readily through the soil as described in Section 4.5. With the small amount of residue material buried, migration of contaminants from this site to a receptor is not likely.

8.36 SITE 36, SNORT STORAGE SHEDS. The SNORT storage sheds are located 1700 feet directly southwest of the SNORT Track breach. Approximately 10 small buildings occupy this site. They include Buildings 25021, 25009, 25028, 25008, 20100 and 30976 (see Figure 2-3 in Chapter 2). The buildings cover an area which is approximately 500 feet by 500 feet. The SNORT Storage Sheds received various hazardous wastes from 1956 to 1962. It was reported to the IAS team that during this period a number of liquid hazardous materials were spilled onto the ground. The materials included red fuming nitric acid, unsymmetrical dimethyl hydrazene, furfal alcohol, and analine. Throughout the period of operations (6 years), it is estimated that approximately 300 gallons of the hazardous wastes were spilled. It is expected that 70 percent of these chemicals volatized on the soil surface. The resulting amount of material that was absorbed into the soil was small. The depth to ground water is about 100-200 feet (Kunkel and Chase, 1969) and therefore the potential for contaminants to migrate from this site to the ground water is low.

8.37 SITE 37, GOLF COURSE LANDFILL. The Golf Course Landfill site is located 3700 feet east along Bladed Access Road from its intersection with Graded Access Roads, and then 600 feet south of Bladed Access Road. Location of this site is shown in Figure 2-3 in Chapter 2. The Golf Course Landfill was open from 1945 to 1964. This landfill received its wastes from the general NAVWPNCEN community. Wastes received at the site consisted of wood, concrete, plastics, paper, tree trimmings, and similar general refuse. It is estimated that approximately 1200 cubic yards of these wastes were disposed of at this site over its 19 years of operation. The material disposed of at this site is inert and therefore no contamination problems exist.

8.38 SITE 38, CACTUS FLAT DISPOSAL TRENCHES. The Cactus Flat disposal trenches are located 30 miles northeast of the NAVWPNCEN Administrative area (see Figure 2-1 in Chapter 2). Special test programs conducted in this small remote area resulted in wastes being generated at the area and disposed of in two trenches at the site. The trenches were approximately 50 feet long by 30 feet wide and 10 feet deep and each trench was separated by a distance of 1/2 mile.

The Cactus Flat Disposal Trenches became operational in the late 60s, and use of the trenches was discontinued in 1979 when they were closed and filled. The type of wastes disposed of at the site consisted of wood, cans, concrete, rubber tires, and metal casings. It is estimated that approximately 1000 cubic yards of wastes were disposed of over the approximately 10 years that the site was operational. The material disposed of at this site was inert and therefore no contamination problems exist.

8.39 SITE 39, CGEH-1 GEOTHERMAL WASTE. In the mid 1970s, geothermal drilling muds and liquid (oily) wastes were disposed of in a open pit adjacent to geothermal drilling operations. The site was located in the northern section of NAVWPNCEN (see Figure 2-1). Volume of wastes could not be determined. The site was closed in 1979 in accordance with Regional Water Quality Control Board guidelines. Ground water was not encountered while drilling geothermal wells to

3000 feet. Due to the depth of ground water and the procedures used for closure, the migration potential of geothermal waste contaminants is very low.

8.40 SITE 40, RANDSBURG WASH #1. From the mid 1950s to the mid 1970s solid waste materials from Randsburg Wash operations were buried in three slit trenches. This site is located about 1 mile north of the administration area near the Canon benchmark (see Figure 2-4 in Chapter 2). Each trench was about 12 feet wide by 70 feet long and 10 feet deep. From the mid 1950s to the mid 1970s. Wastes deposited include primarily ordnance type waste such as shell casings and fuzing. In addition, lumber, rope and scrap metal is still visible in one trench. There is no evidence that liquid or hazardous wastes were deposited in these trenches. The material disposed of at this site is inert and, therefore, no contamination problems exist.

8.41 SITE 41, RANDSBURG WASH #2. Two large disposal pits about 0.75 miles northeast of the administration area were the main disposal sites at Randsburg Wash from the early 1950s until their use was discontinued in 1980 (see Figure 2-4 in Chapter 4). The pits were about 75 feet by 100 feet by 20 feet deep. The waste received included general refuse from the area such as wood, construction materials, paint cans, glass and plastics. Due to the electronic research at Randsburg Wash a significant amount of waste (3 cubic yards week, 1080 cubic yards/30 years) from the electrical shops, such as wire, transistors, and small capacitors, were deposited in the disposal pits. Also, the machine and mechanical shops reportedly disposed of some waste cleaners, solvents, and oils such as TURCO, kerosene, acetone, and used motor oil. The quantities have been estimated to be 2000-3000 gallons of waste oil and a similar quantity of solvents during the life of the disposal pits. In the 1950s and early 1960s the waste pile was burned regularly so that much of these wastes were volatalized.

There are two water wells used for the potable supply at the Randsburg Administration area which are located about 1-1.5 miles southeast of Site 41. However, the depth to water is 200-250 feet. The transmissivity is only 1000 gallons per day per foot which indicates a migration movement 200 times slower than the China Lake complex. The regular burning of the waste and low transmissivity makes it unlikely that contamination will reach the ground water. In addition, the groundwater movement is suspected to be towards the northwest away from the water well receptors.

8.42 SITE 42, RANDSBURG WASH #3. A past disposal site for fuel drums is located about 20 miles east of the administration area, just north of Randsburg Road at the Fath benchmark (see Figure 2-4 in Chapter 2). This disposal site consists of a pit about 30 feet by 30 feet by 4 feet deep which was utilized for the one time disposal of about thirty 55-gallon drums of fuel (type unknown). The fuel was burned in the drums so that only the empty drums remain. Some are partially buried. There is also an abandoned amphibious vehicle at the site. The burning took place in the mid-1970s and the site has not been used for any other subsequent disposal. There is no visible evidence of spilled fuel on the ground. Therefore no contamination of this site is documented.

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APPENDIX A

GOVERNMENT AGENCIES CONTACTED FOR THE INITIAL ASSESSMENT STUDY AT NAVWPNCEN CHINA LAKE

- Naval Energy and Environmental Support Activity (NAVENENVSA), Port Hueneme, California
- NAVFACENGCOM Command Historian, Naval Construction Battalion Center, Port Hueneme, California
- Naval Facilities Engineering Command (NAVFACENGCOM) Headquarters, Alexandria, Virginia
- Naval Facilities Engineering Command, Western Division, San Bruno, California: Planning Branch, Geotechnical Branch, Facilities Planning Department, Real Estate Branch, and Natural Resources Management Branch.
- Ordnance Environmental Support Office, Naval Ordnance Station, Indian Head, Maryland
- Department of Defense Explosive Safety Board, Alexandria, Virginia
- Navy Historical Center, Operations Archives, Navy Yard, Washington, D.C.
- Naval Library, Navy Yard, Washington, D.C.
- National Archives: Navy and Old Army Branch, Still Pictures Branch, and Cartographic Branch, Washington, D.C.; Federal Records Center and Suitland, Maryland and Laguna Niguel, California